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IMPACT OF AIRCRAFT EMISSIONS ON AIR QUALITY IN THE VICINITY OF AIRPORTS

Volume II: An Updated Model Assessment of Aircraft Generated Air Pollution at LAX, JFK, and ORD

Office of Environment and Energy
Washington, D.C. 20591

IMPACT OF AIRCRAFT EMISSIONS ON AIR QUALITY IN THE VICINITY OF AIRPORTS —Volume II FAA-EE-80-09B

July 1980

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16. Abstract

This report documents the results of the Federal Aviation Administration (FAA)/Environmental Protection Agency (EPA) air quality study which has been conducted to assess the impact of aircraft emissions of carbon monoxide (CO), hydrocarbons (HC), and oxides of nitrogen (NO_x) in the vicinity of airports. This assessment includes the results of recent modeling and monitoring efforts at Washington National (DCA), Los Angeles International (LAX), Dulles International (IAD), and Lakeland, Florida airports and an updated modeling of aircraft generated pollution at LAX, John F. Kennedy (JFK) and Chicago O'Hare (ORD) airports. The Airport Vicinity Air Pollution (AVAP) model which was designed for use at civil airports was used in this assessment. In addition the results of the application of the military version of the AVAP model, the Air Quality Assessment Model (AQAM), are summarized.

Both the results of the pollution monitoring analyses in Volume I and the modeling studies in Volume II suggest that:

- Maximum hourly average CO concentrations from aircraft are unlikely to exceed 5 parts per million (ppm) in areas of public exposure and are thus small in comparison to the National Ambient Air Quality Standard of 35 ppm.
- Maximum hourly HC concentrations from aircraft can exceed 0.25 ppm over an area several times the size of the airport, and
- While annual average NO_2 concentrations from aircraft are estimated to contribute only 10 to 20 percent of the NAAQS limit level, these concentrations, when averaged over a one hour time period are estimated to produce concentrations as high as 0.5 ppm if one assumes that all engine produced NO is converted to NO_2 by the time these emissions reach places of public exposure. This value is at the upper end of the concentration range being considered for the short term NO_2 standard presently under review and can not be ignored. However a decision on the influence of aircraft emissions on a short term standard must await the release of this standard and the results of research under way to determine the rate at which engine produced NO converts to NO_2 in the ambient air.

This report, IMPACT OF AIRCRAFT EMISSIONS ON AIR QUALITY IN THE VICINITY OF AIRPORTS, is printed in two volumes with the following subtitles; VOLUME I: Recent Airport Measurement Programs, Data Analyses, and Sub-Model Development; and VOLUME II: An Updated Model Assessment of Aircraft Generated Air Pollution at LAX, JFK, and ORD.

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PREFACE

This document has been prepared by the Energy and Environmental Systems Division of Argonne National Laboratory at the request of the Federal Aviation Administration. The report attempts to realistically simulate the air quality impact of aircraft in and around the airport property under adverse dispersion conditions. No attempt has been made to include the effect of non-aircraft sources.

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1 INTRODUCTION

During the past ten years, a number of agencies and groups concerned with the air quality impact of major airports have undertaken air pollution monitoring programs as well as theoretical studies based on the use of atmospheric dispersion algorithms. Lorang (1978) has recently provided an extensive review and assessment of these efforts while Smith (1978) has summarized the characteristics of and approximations used in, the major air quality models used in the studies. Smith observes that the "Argonne Airport Vicinity Air Pollution Model (AVAP) (Wang et al, 1975) is the most sophisticated code yet developed for predicting the impact of all sources at commercial airports." Nevertheless, the AVAP code contains a number of approximations that may require revision as new information becomes available regarding emissions inventory detail, aircraft operations, and plume dynamics.

This report describes simulations of the air quality impact of aircraft at and around Los Angeles International (LAX) John F. Kennedy (JFK), and O'Hare (ORD) airports during hours of peak aircraft operation and under the most adverse dispersion conditions anticipated for those hours. No attempt is made to include the effect of non-aircraft sources. Data from a short field program conducted at the three airports are also presented here. This data provided some of the updated input information needed for the application of the AVAP model to the airports.

Updates and refinements used in the present AVAP assessment are based on new information recently reported in the Literature as well as the results of the field program mentioned above and include:

- Use of updated aircraft engine emission factors, (Pace, 1977).
- Direct input of the hourly number of aircraft departures by aircraft type. The new computerized Official Airline Guide (OAG) permits easy access to this previously difficult-to-obtain quantity and eliminates the need for estimating departures based on the tie history of arriving aircraft.
- Inclusion of plume rise. Plume rise information obtained in the three-tower Dulles experiments (Volume I, Section 4.5) was used for the taxi/idle mode. The

plume rise was taken as $\Delta H(ft) = 31.2 + 386/u(ft/sec)$ which represents an average for all aircraft types observed at Dulles. This experiment simultaneously determined initial plume dimensions to be $\sigma_x(0) = 60$ ft and $\sigma_z(0) = 26$ ft. for the taxi mode. No plume rise was considered for the other, high-speed, aircraft modes.

- Inclusion of enhanced vertical dispersion due to plume rise. The vertical dispersion coefficient was modified by the relation σ_z^2 (modified) $= \sigma_z^2$ (original) $+ (\Delta H)^2/10$, as suggested by Pasquill. (1976)

- Use of revised estimate of takeoff plume dimensions. Single event data obtained during the DCA experiment (Volume I, Section 3.6) established these parameters tentatively as $\sigma_x(0) = 70$ ft and $\sigma_z(0) = 84$ ft for the aircraft (i.e., DC-9, B727, and B737) operating at DCA.

- Realistic modeling of the aircraft departure queue. Departure queue lengths were based on the observations taken during the above mentioned field program; however, observed times-in-queue were found to agree closely with AVAP computed estimates and were thus not input.

- Use of revised, airport-specific times-in-mode. Rising fuel costs as well as changes in airport geometry and operational modes might cause time-in-mode factors to differ from the previously used factors found in the U.S. EPA's *Compilation of Air Pollutant Emission Factors*, AP-42 (1975).

Other points of interest:

- Use of time-dependent dispersion coefficients in the horizontal to account for wind direction meander at low wind speeds. Although these dispersion coefficients were used in an earlier version of the AVAP model, their use is a departure from the more conventional Gaussian modeling approach in which Turner's Workbook values of dispersion are used. For this reason some discussion is worthwhile. For his Nashville study, Turner (1964) had developed a set of time-dependent dispersion curves that were based on a transformation of the original Pasquill-Gifford curves given by Gifford (1961) and by Turner (1968). Later, in his unpublished study of St. Louis, Turner (1970) modified these time-dependent curves to allow for the urban heat island effect and increased surface roughness and a characteristic averaging time of two hours. These latter curves have been further modified for use in the AVAP model and in the AQAM model. In particular, only a one-hour averaging time is used in both of these models. A more detailed discussion of these curves along with comparisons with other choices of dispersion coefficients found in the literature is given by Rote and Wangen (1975). The important feature of these dispersion coefficients in the present study is that under the low wind speed conditions considered here, these coefficients lead to substantially more rapid dispersion than the more conventional values reported for example in Turner's Workbook (1968). Furthermore, evidence now exists to support the choice of the time-dependent curves extrapolated to low wind speeds for use in low wind speed models. See, for example, Yamartino (1977), for a fuller discussion on this topic.

- Use of $1/r^p$ interpolation between grid points. Pollutant concentrations (doses) are known to fall off with a power of p 0.9 from line sources and p 1.8 from point sources. Use of linear interpolation tends to overestimate the area covered by high concentration contours resulting from localized pollution "hotspots." The average value $p = (0.9+1.8)/2 = 1.35$ is used in this study.

2 FIELD PROGRAM RESULTS

The field program at LAX, JFK, and ORD -- conducted by Dr. Douglas Smith and his associates from Environmental Research and Technology Inc. (ERT) under contract to Argonne National Laboratory -- consisted of several days of observations (usually from the airport's control tower) of aircraft movements on the ground. These observations were supplemented by numberous conversations with tower chiefs and operations managers to determine those conditions leading to the greatest quantity of ground level aircraft emissions. Season, day of the week, time of day, and meteorology were found to be the most significant factors in defining these "worst case" operational conditions.

Typical times-in-mode are given in Table 1 for departing aircraft and in Table 2 for arriving aircraft. Since most of the sampling periods coincided with the peak activity hours, the taxi/idle and queueing times listed may be overestimates of the daily average times. The times given in the Compilation of Air Pollutant Emission Factors (EPA, 1975) are included for comparison.

Table 3 presents the observed runway usage of the three airports. It should be noted, however, that these airports have more than one operational configuration of runway use and that the observed percentages listed in the table span multiple configurations. The actual runway and taxiway percentage utilizations by aircraft class for the configuration corresponding to "worst case" meteorological and operational conditions are presented in Tables A.9a, A.9b, and A.9c.

The diurnal variations in aircraft activity at the three airports are presented in Table 4. These data resulted from a tabulation of operations for August 4, 1977, prepared by the Federal Aviation Administration, using the computerized OAG data base. It should be noted that August is the busiest month at major U.S. airports and that Thursday (e.g., August 4) is the busiest day of the week. A finer breakdown for each of the 12 aircraft types considered is given in Table A.6.

Observations of both gate usage as a function of aircraft type and taxi speeds as a function of aircraft mode (inbound or outbound) and taxiway segment were also gathered and are tabulated in Table A.5.

Table 1. Observed Time-in-Mode for Departing Aircraft (mins)[a]

Aircraft	Taxi/Idle			Queue			Total[b] AP-42	Takeoff			
	JFK	ORD	LAX	JFK	ORD	LAX		JFK	ORD	LAX	AP-42[c]
Jumbo	11.35(6)	7.39(9)	6.89(33)	5.38(5)	8.27(6)	3.11(33)	19.00	.69(4)	.49(2)	.63(31)	.70
Long Range	8.46(2)	7.18(6)	7.61(17)	3.78(4)	6.94(6)	4.04(17)	19.00	.55(4)	.56(4)	.53(17)	.70
Med. Range	8.29(3)	7.00(16)	4.22(41)	2.92(2)	6.27(16)	4.75(43)	19.00	.39(6)	.39(6)	.53(44)	.70

[a]Number of aircraft in each sample indiated in parentheses.

[b]Includes taxi/idle and queue; from Reference 8.

[c]From Reference 8.

Table 2. Observed Time-in Mode for Arriving Aircraft (mins)[a]

Aircraft	Roll			Taxi/Idle			Total[b] AP42
	JFK	ORD	LAX	JFK	ORD	LAX	
Jumbo	0.84(18)	1.00(1)	0.80(24)	6.78(18)	17.00(2)	5.42(21)	7.00
Long Range	0.61(18)	no data	0.75(23)	6.50(18)	no data	3.06(19)	7.00
Medium Range	0.60(22)	0.56(3)	0.68(51)	5.32(22)	6.72(4)	2.96(43)	7.00

[a]Number of Aircraft in each sample indicated in parentheses.

[b]Includes roll and taxi/idle; from Reference 8.

Table 3. Observed Runway Utilization (%)

Airport	Arrivals Runway	Arrivals % Use	Departures Runway	Departures % Use
O'Hare				
(9 arrivals,	22L	68	32R	47
36 departures	22R	11	32L	44
observed)	14L	11	27L	6
	14R	11	4L	3
John F. Kennedy				
(58 arrivals,	13L	86	13L	8
13 departures	13R	7	13R	85
observed)	22L	5	22L	8
	22R	2	22R	0
Los Angeles				
(80 arrivals,	24R	10	24R	2
90 departures	24L	10	24L	41
observed)	25R	46	25R	49
	25L	34	25L	8
LAX data from NOISE Network printout, 3/31/78				
	24	26	24	32
	25	74	25	68

Table 4. Diurnal Variation in Airport Activity (August 4, 1977)

Hour	No. of Departures/Arrivals JFK	ORD	LAX
00-01	7/12	2/3	16/17
01-02	6/5	4/15	8/9
02-03	3/11	9/9	3/6
03-04	5/4	11/5	4/3
04-05	4/0	9/9	2/5
05-06	0/5	6/19	2/4
06-07	3/11	22/12	11/13
07-08	14/11	56/49	33/24
08-09	21/18	59/50	51/30
09-10	37/8	49/64	47/21
10-11	20/13	68/57	38/39
11-12	18/15	69/58	30/40
12-13	18/10	49/65	44/34
13-14	15/18	63/66	44/25
14-15	12/25	78/79	22/34
15-16	14/45	71/52	31/37
16-17	28/44	54/71	28/34
17-18	30/39	67/68	30/33
18-19	35/20	69/58	32/43
19-20	44/31	61/67	37/47
20-21	30/28	55/67	22/37
21-22	42/25	47/31	24/34
22-23	19/9	18/16	29/25
23-24	8/10	12/18	22/20

3 AIRPORT INDEPENDENT MODEL INPUTS

AVAP requires rather detailed information regarding factors that determine the temporal and spatial distribution of pollutants as well as the total mass of emissions. Table 5 lists the 12 aircraft types considered in the present simulations, along with the engine type and number of engines for each aircraft type. The aircraft are assigned a class designation which is a consideration in runway/taxiway usage, and a range that affects aircraft time-in-mode via consideration of relative maneuverability on the ground. The emission rates of the 11 types of aircraft engines are given in Table 6.

Table 5. Aircraft Classification Scheme

Type	Aircraft	Class	Range (miles)	Engine Manufacturer and Model Number	No. of Engines	Auxiliary Power Unit
1	747	Jumbo/wide body	5,000-8,000	Pratt & Whitney, JT9D-7	4	yes
2	L1011	Jumbo/wide body	5,000-8,000	Rolls Royce, RB-211-22B	3	yes
3	DC10	Jumbo/wide body	5,000-8,000	General Electric, CF6-6D	3	yes
4	D11	Jumbo/wide body	5,000-8,000	General Electric, CF6-50C	3	yes
5	707,DC8	Long-range	3,000-5,000	Pratt & Whitney, JT3D-7	4	no
6	727	Medium-range	1,000-3,000	Pratt & Whitney, JT8D-17	3	yes
7	737, DC9, B11	Medium-range	1,000-3,000	Pratt & Whitney, JT8D-17	2	yes
8	DC3, AN, CN4	Turboprop	1,000-3,000	AVCO Lycoming, TID540 J2B2	2	no
9	LOE, DBH	Turboprop	1,000-3,000	Garrett AiResearch, TPE731-2	2	no
10	FKF, CV5, FK7	Turboprop	1,000-3,000	Rolls Roys, RDa7	2	no
11	HPJ, DHT, SWM, ND2, DHH, BE9	Small turboprop	<1,000	Pratt & Whitney, PT6A-27	2	no
12	DAF	Small turboprop	<1,000	General Electric, 700-2D	2	no

Table 6. Emission Rates of Aircraft Engines[a] (lbs/hr)

Engine Manufacturer and Model	Taxi/Idle	Landing	Take-off	Approach	Climbout
	Carbon Monoxide				
Pratt & Whitney, JT9D-7	142.2	93.4	3.2	44.6	6.6
Pratt & Whitney, JT3D-7	140.8	96.3	9.0	60.1	15.9
Rolls Royce, RB-211-22B	137.6	98.9	5.6	93.8	14.9
General Electric, CF6-50C	88.0	56.5	0.4	22.7	4.7
General Electric, CF6-6D	65.1	44.7	8.3	23.2	6.8
Pratt & Whitney, JT8D-17	39.1	28.4	7.0	20.2	7.9
Rolls Royce, RDa7	37.6	27.1	4.8	21.5	4.3
Garrett AiResearch, TPE731-2	11.1	8.6	1.9	9.5	1.8
Pratt & Whitney, PT6A-27	7.4	5.3	0.4	4.9	0.5
General Electric, 700-2D	71.3	65.7	57.4	57.0	58.1
AVCO Lycoming, TIO540 J2B2	32.4	129.4	374.5	125.4	300.8
	Hydrocarbons				
Pratt & Whitney, JT9D-7	55.1	34.0	0.8	4.6	1.3
Pratt & Whitney, JT3D-7	124.6	77.0	5.0	6.5	3.3
Rolls Royce, RB-211-22B	100.1	72.2	29.1	32.2	8.3
General Electric, CF6-50C	36.2	21.8	0.2	0.1	0.2
General Electric, CF6-6D	21.8	16.2	8.3	7.0	6.8
Pratt & Whitney, JT8D-17	10.1	6.4	0.5	1.4	0.4
Rolls Royce, RDa7	25.5	17.4	8.8	0.0	2.1
Garrett AiResearch, TPE731-2	4.1	2.7	0.1	1.5	0.1
Pratt & Whitney, PT6A-27	5.8	3.5	0.0	0.5	0.0
General Electric, 700-2D	8.3	5.2	0.3	1.3	0.2
AVCO Lycoming, TIO540 J2B2	1.7	2.0	3.2	1.3	3.4
	Oxides of Nitrogen				
Pratt & Whitney, JT9D-7	5.73	123.14	474.60	35.25	282.30
Pratt & Whitney, JT3D-7	2.23	34.29	126.40	16.35	78.60
Rolls Royce, RB-211-22B	5.31	129.31	504.10	32.26	391.90
General Electric, CF6-50C	3.02	171.29	670.95	52.80	452.20
General Electric, CF6-6D	4.88	121.77	467.50	41.54	309.20
Pratt & Whitney, JT8D-17	3.91	53.94	202.06	19.39	123.40
Rolls Royce, RDa7	0.29	2.31	8.51	0.57	5.55
Garrett AiResearch, TPE731-2	0.54	8.05	29.80	3.59	7.18
Pratt & Whitney, PT6A-27	0.28	1.25	3.32	1.80	2.80
General electric, 700-2D	0.82	4.26	14.60	1.65	9.98
AVCO Lycoming, TIO540 J2B2	0.01	0.05	0.09	0.13	0.05

[a]All emission rates except those for land are from Reference 3. The landing emission rates are computed by assuming that the landing operation consists of 60% idle, 24% takeoff thrust (i.e., thrust reversers), and 16% approach thrust (to account for the spool down/up/down cycle).

4 AIRPORT DEPENDENT MODEL ASSUMPTIONS AND RESULTS

4.1 LOS ANGELES INTERNATIONAL (LAX)

The diurnal cycle of aircraft arrivals and departures at LAX on August 4, 1977 is given in Fig. 1. As considerably more emissions of all pollutants accompany a departure, Hour 8 (0800-0900 PDT) is the likely "worst case" hour with Hours 12 and 13 as possible alternative candidates. However, meteorological considerations rule out Hours 12 and 13; a moderate sea breeze usually develops by this time of day, resulting in rapid dispersion. Hour 8, on the other hand, is probably the last hour of the morning for which, in August, one would have the light wind, surface based inversion conditions that could lead to serious air pollution (Keith, 1978).

Hour 8 is thus selected as the "worst case" hour with assumed (i.e., not specific to August 4, 1977) "worst case" meteorological conditions consisting of E stability (moderately stable), a 350 ft. mixing depth (Hallanger, 1975), and a 2 knot wind with directions as yet unspecified (Volume 1, Section 2.3).

Figure 2 depicts the major aircraft line sources at LAX, including runways, taxiways, queueing segments, and terminal zone connectors. A breakdown of the Hour 8 aircraft emissions by line source type is given in Table 7. Comparison of the ground level figures with the automotive emission rates in AP-42 (EPA, 1975) suggests that the airport's aircraft equivalent in number of cars is ≃ 500 for CO (at idle), ≃ 2600 for THC (at idle), and ≃ 800 for NO_x (at 45mph).

AVAP computations were performed using a 0.25 mile receptor grid (Fig. 2 has a superposed 0.5 mile grid) for wind directions of $\theta = 360°$ (Fig. 3), $\theta = 100°$ (Fig. 4) and $\theta = 270°$ (Fig. 5). The west ($\theta = 270°$) wind computations were then redone (Fig. 6) for the eastern portion of the southern runway complex to show the result of using increased grid resolution (0.05 mile). It should be noted, however, that the light winds in the morning are almost always from the east and rarely from the west or north.

Maximum hourly average CO concentrations are found to be low compared to the National Ambient Air Quality Standards limit of 35 ppm. Hydrocarbon levels of a few ppm, while not a direct health hazard, are high compared to the 6-9 a.m. guideline value of 0.24 ppm. The area covered by the 0.25 ppm

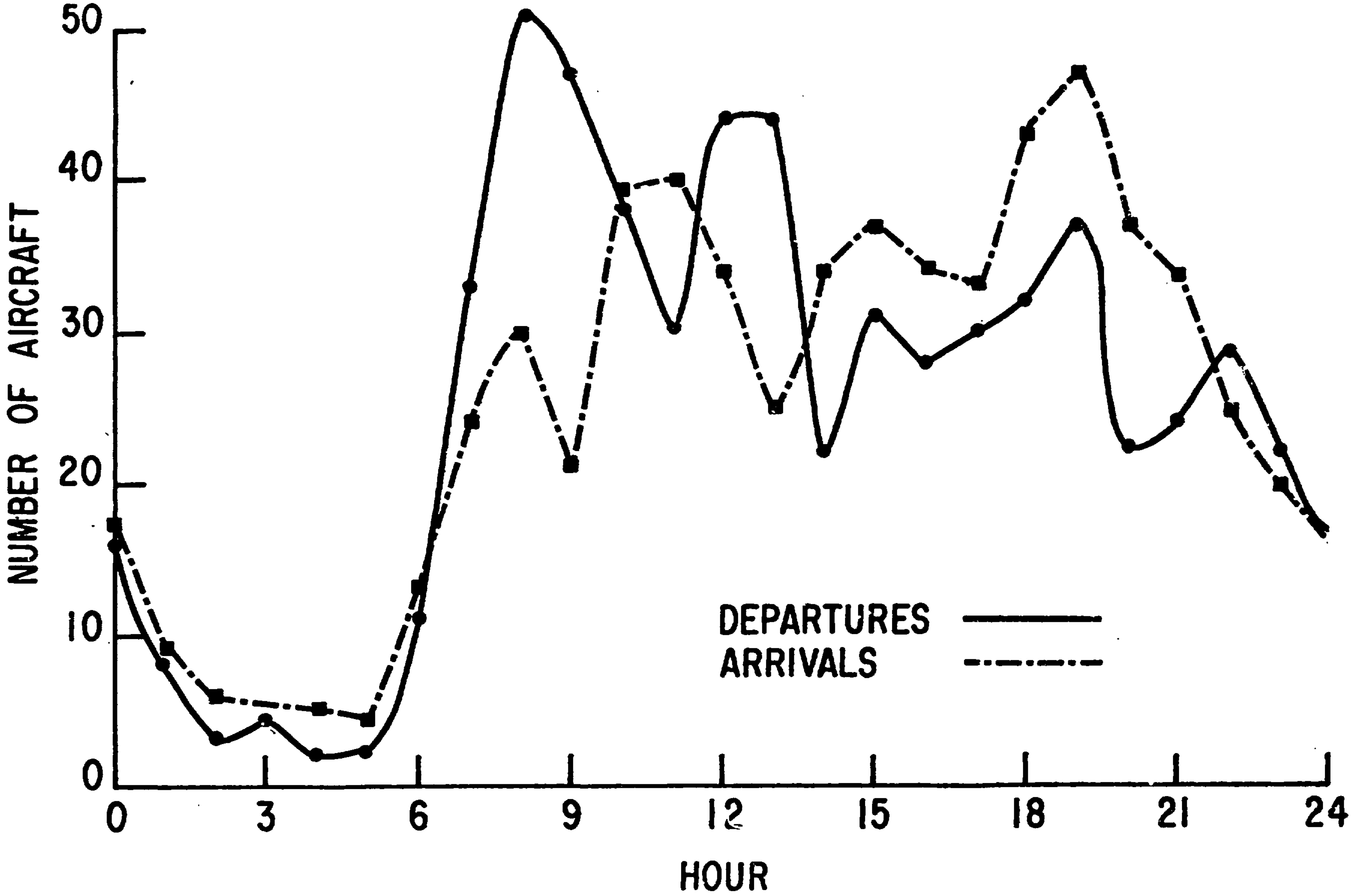

Figure 1. Hourly Number of Arrivals and Departures at LAX Versus Hour of the Day

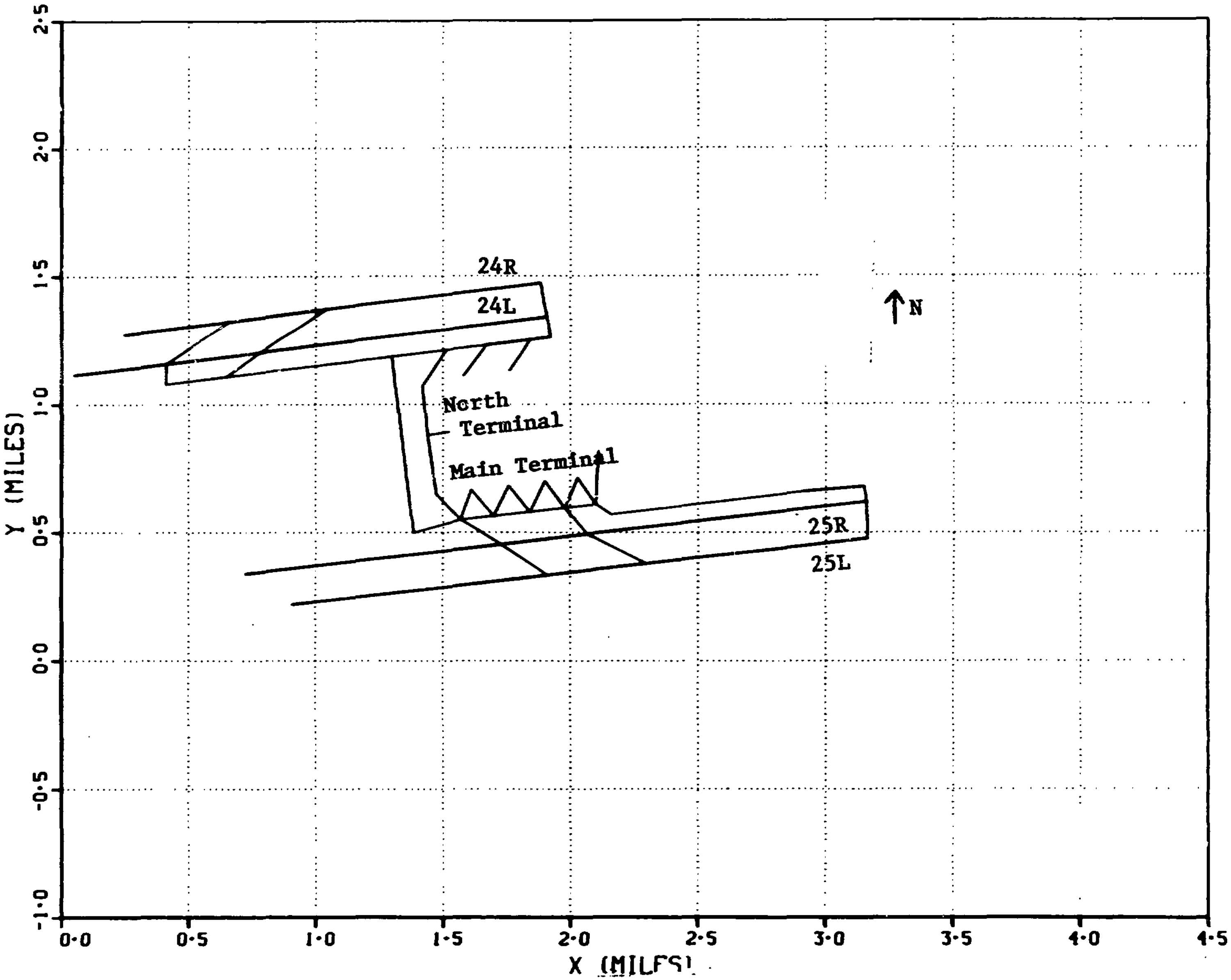

Figure 2. Map of Aircraft Line Sources at LAX

THC contour is estimated to be several times the airport area, so that aircraft-contributed hydrocarbon emissions may indeed aggravate oxidant problems in the airport vicinity. Finally, NO_x values are comparable to potential NO_2 hourly standards in the range 0.2-0.5 ppm, which suggests a more detailed look at the NO_2 situation either observationally or via models that include the reaction $NO + O_3 \rightarrow NO_2 + O_2$ plus NO_2 photolysis.

Table 7. Summary of Aircraft Emissions for Hour 8 (0800-0900 PDT) at Los Angeles International Airport

	Emissions (10^3 lbs)		
Location	CO	THC	NO_x
Runways	0.04	0.02	0.44
Taxiways	1.47	0.80	0.08
Queue	1.28	0.74	0.07
Terminal	0.38	0.18	0.04
Total on Ground	3.17	1.74	0.63
Approach and Climbout	0.14	0.02	0.81
Total	3.31	1.76	1.44

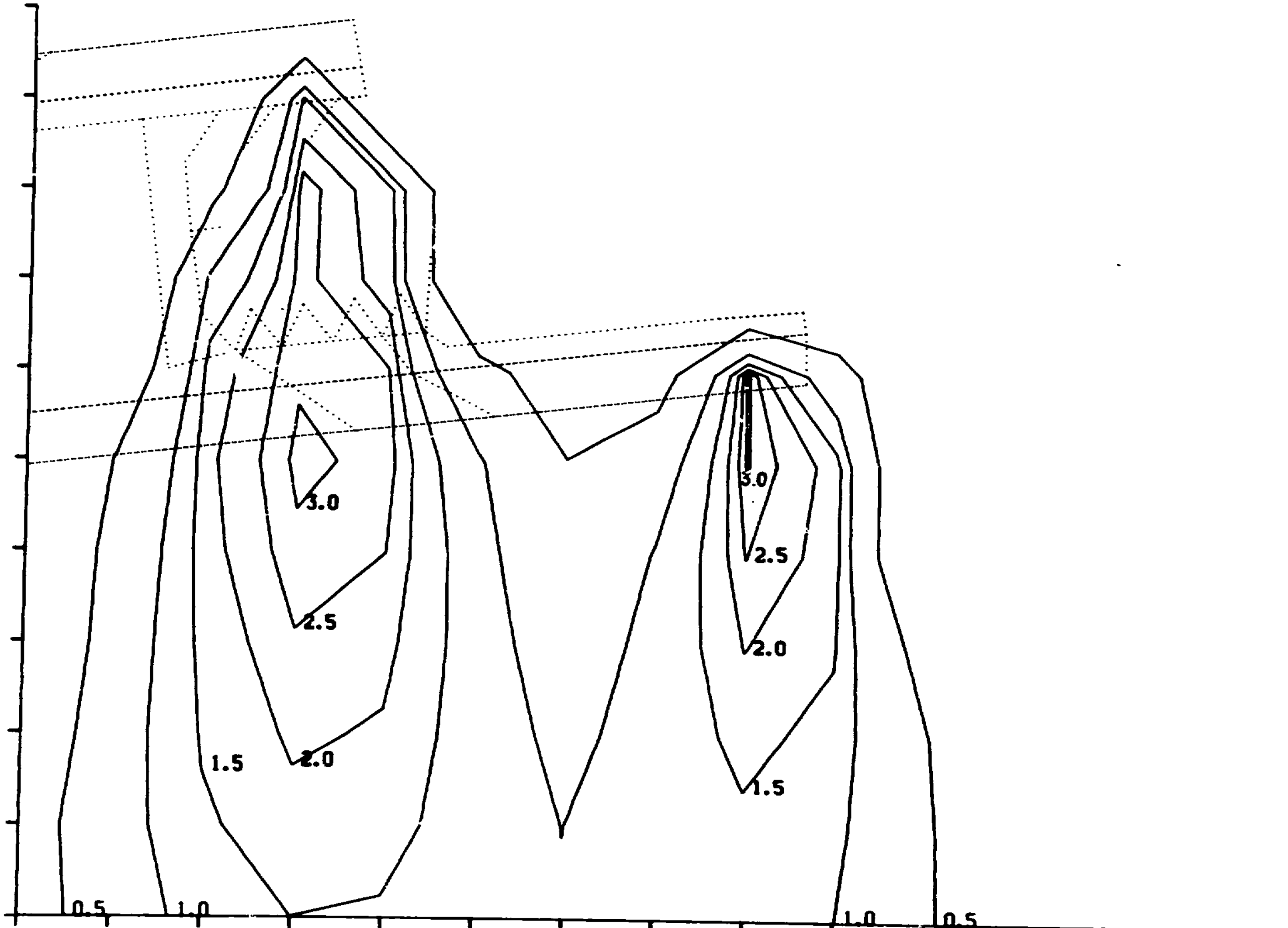

Figure 3a. CO Concentration Isopleths from Aircraft Operations at LAX for Hour 8 Assuming E Stability, a 350' Mixing Depth, and a 2 Knot Wind from the North (θ = 360°), Grid Size = 0.25 Miles

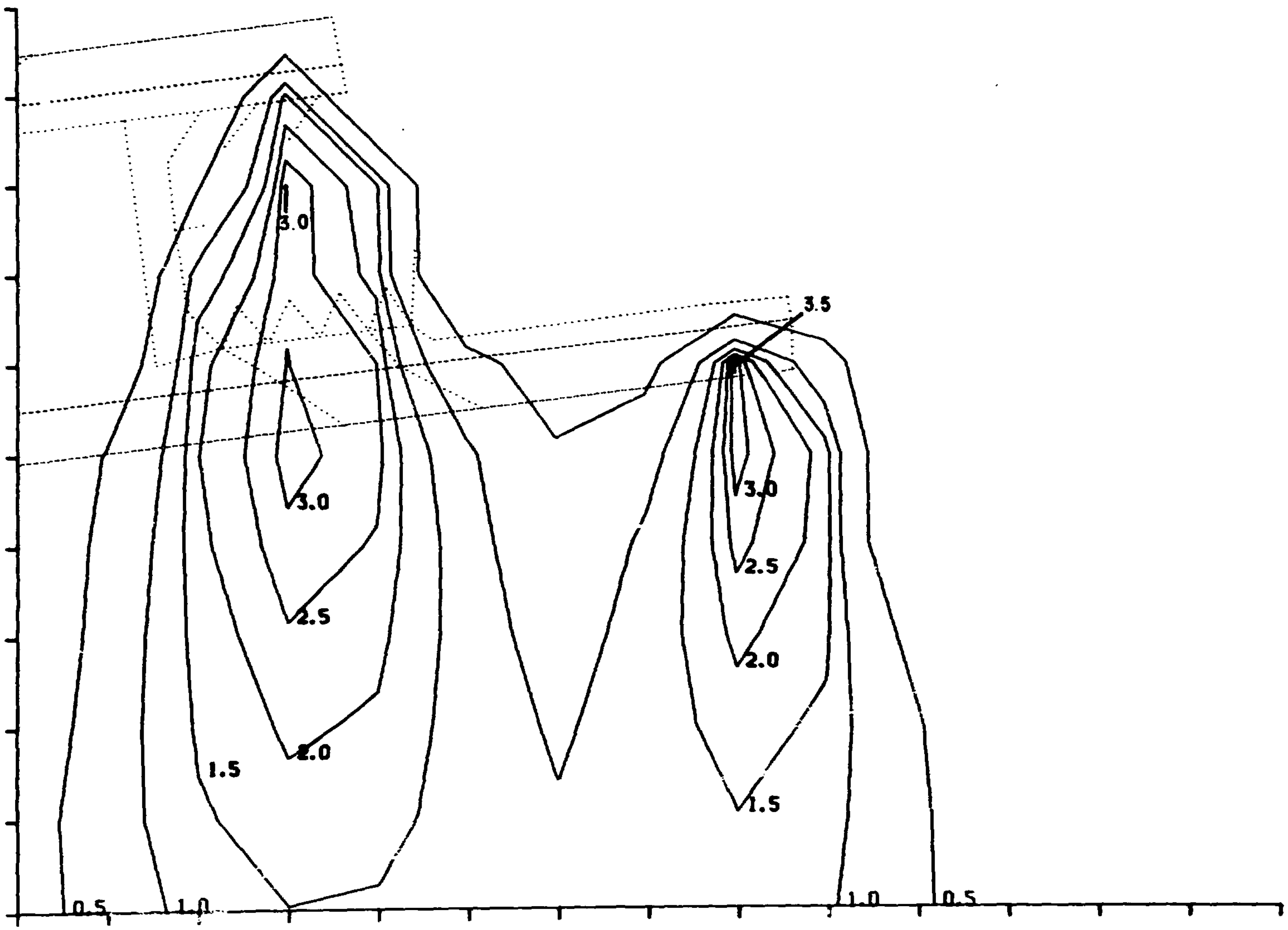

Figure 3b. THC Concentration Isopleths from Aircraft Operations at LAX for Hour 8 Assuming E Stability, a 350' Mixing Depth, and a 2 Knot Wind from the North ($\theta = 360°$), Grid Size = 0.25 Miles

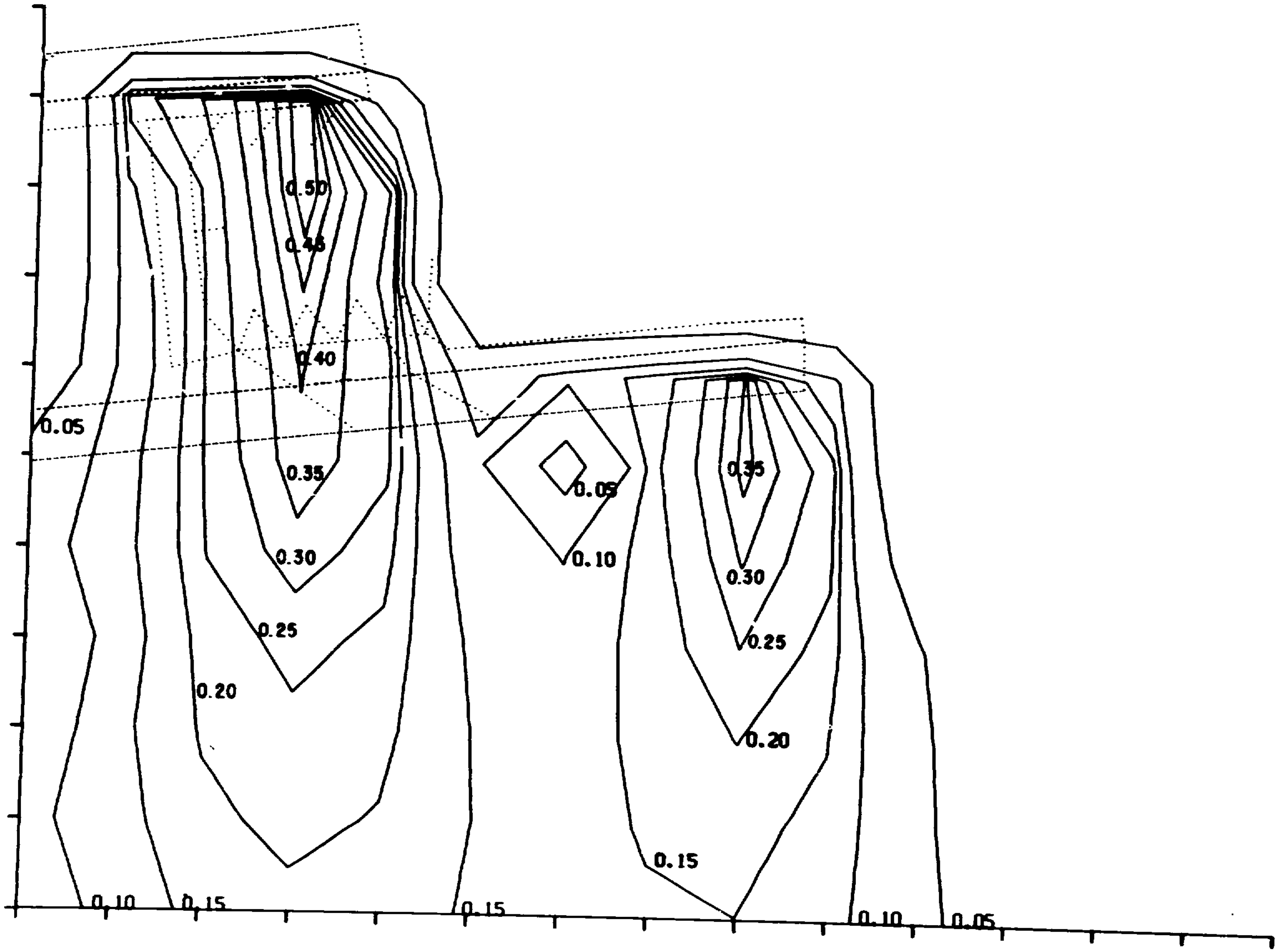

Figure 3c. NO_x Concentration Isopleths from Aircraft Operations at LAX for Hour 8 Assuming E Stability, a 350' Mixing Depth, and a 2 Knot Wind from the North (θ = 360°), Grid Size = 0.25 Miles

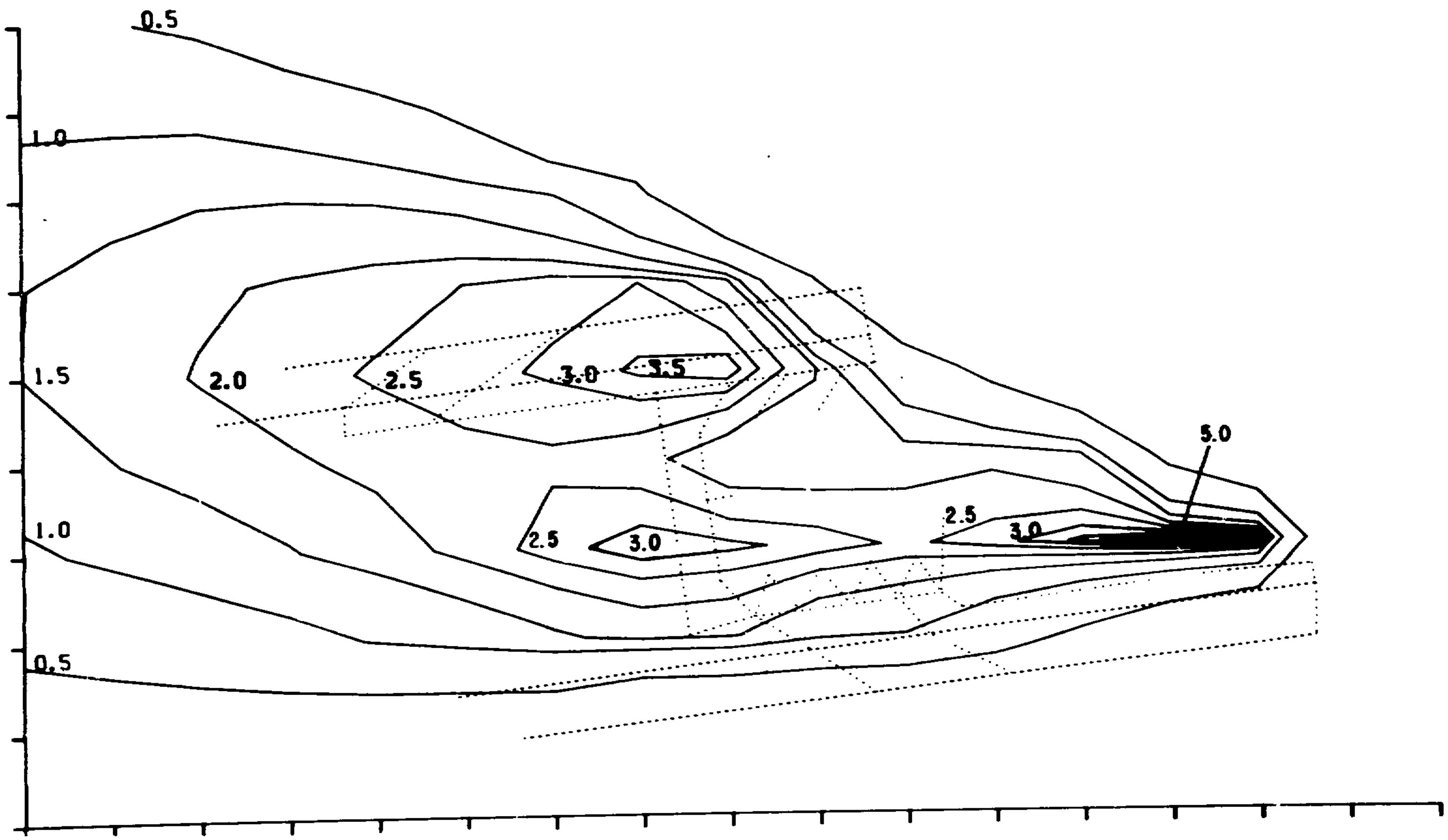

Figure 4a. CO Concentration Isopleths from Aircraft Operations at LAX for Hour 8 Assuming E Stability, a 350' Mixing Depth, and a 2 Knot Wind from the East (θ = 100°), Grid Size = 0.25 Miles

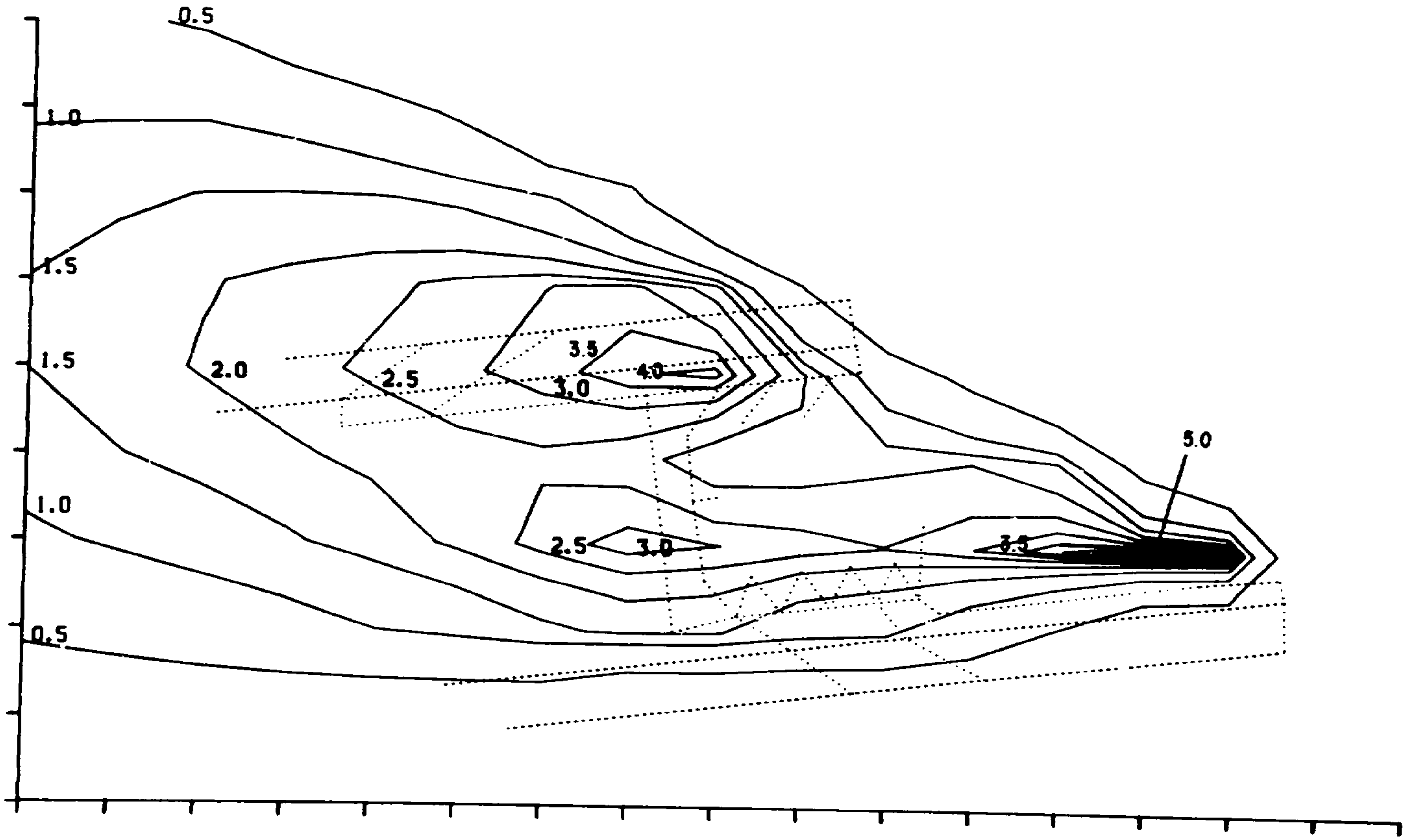

Figure 4b. THC Concentration Isopleths from Aircraft Operations at [illegible] for Hour 8 Assuming E Stability, a 350' Mixing Depth, and a 2 Knot Wind from the East ($\theta = 100°$), Grid Size = 0.25 Miles

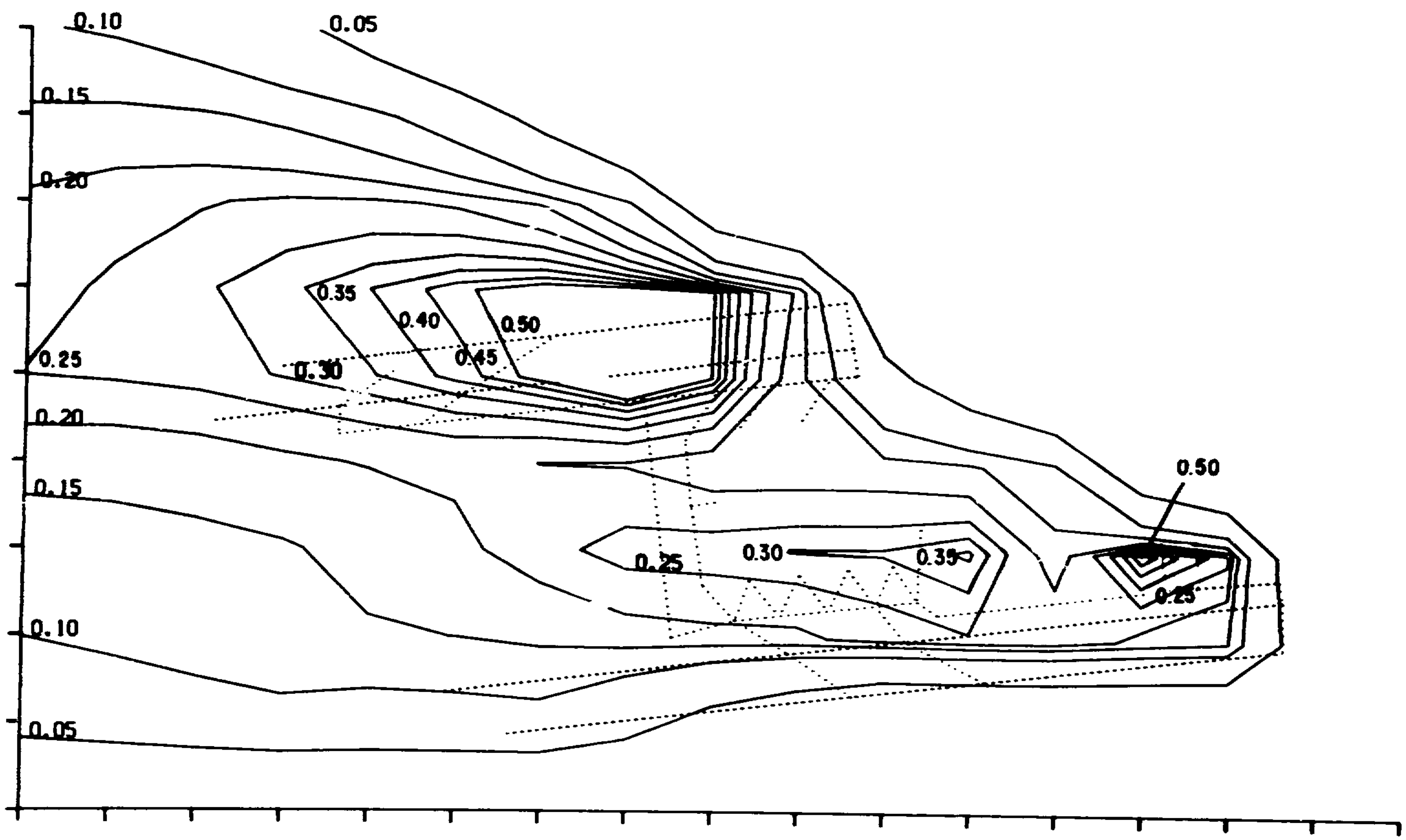

Figure 4c. NO_x Concentration Isopleths from Aircraft Operations at LAX for Hour 8 Assuming E Stability, a 350' Mixing Depth, and a 2 Knot Wind from the East (θ = 100°), *Grid Size = 0.25 Miles*

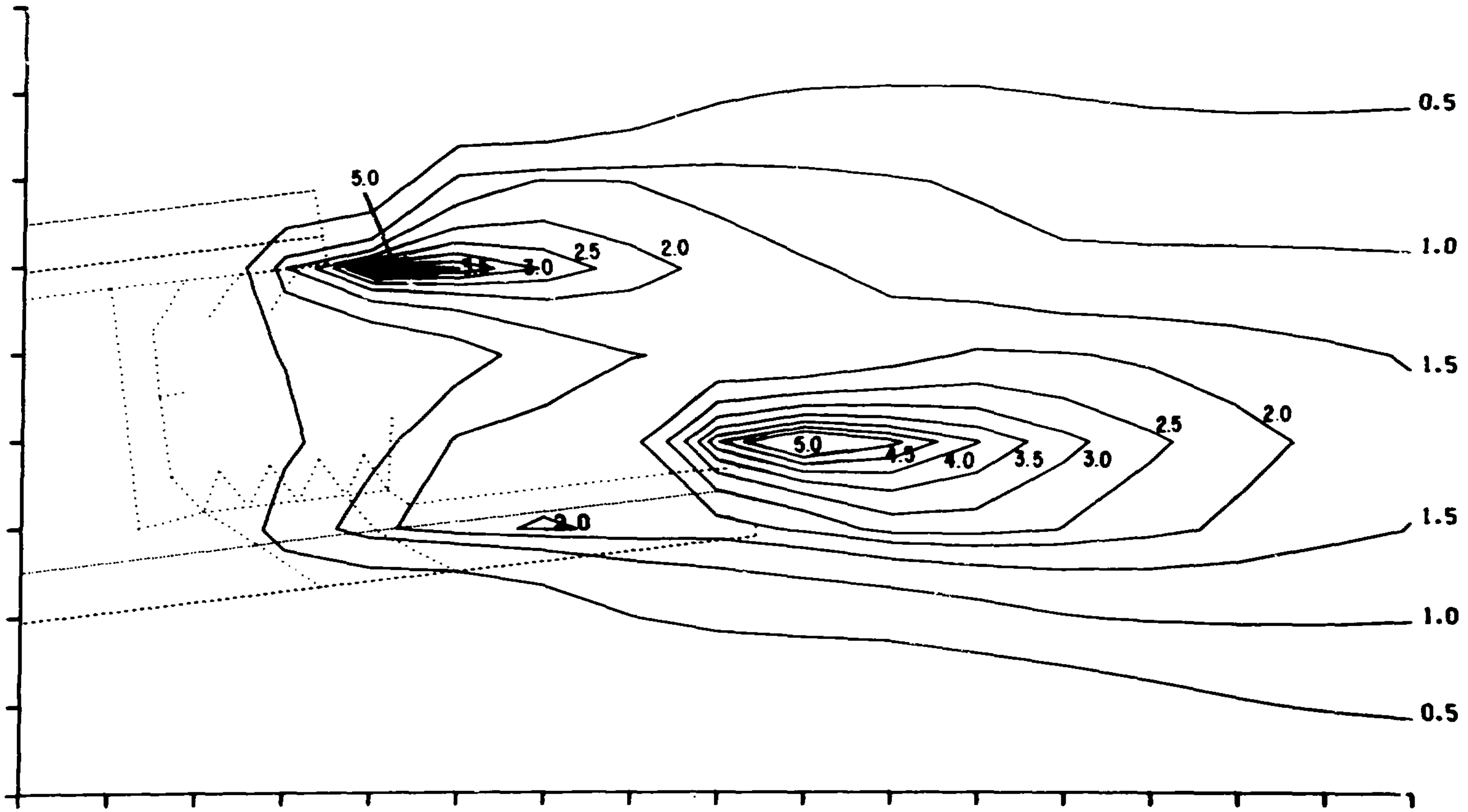

Figure 5a. CO Concentration Isopleths from Aircraft Operations at LAX for Hour 8 Assuming E Stability, a 350' Mixing Depth, and a 2 Knot Wind from the West ($\theta = 270^{\circ}$), Grid Size = 0.25 Miles

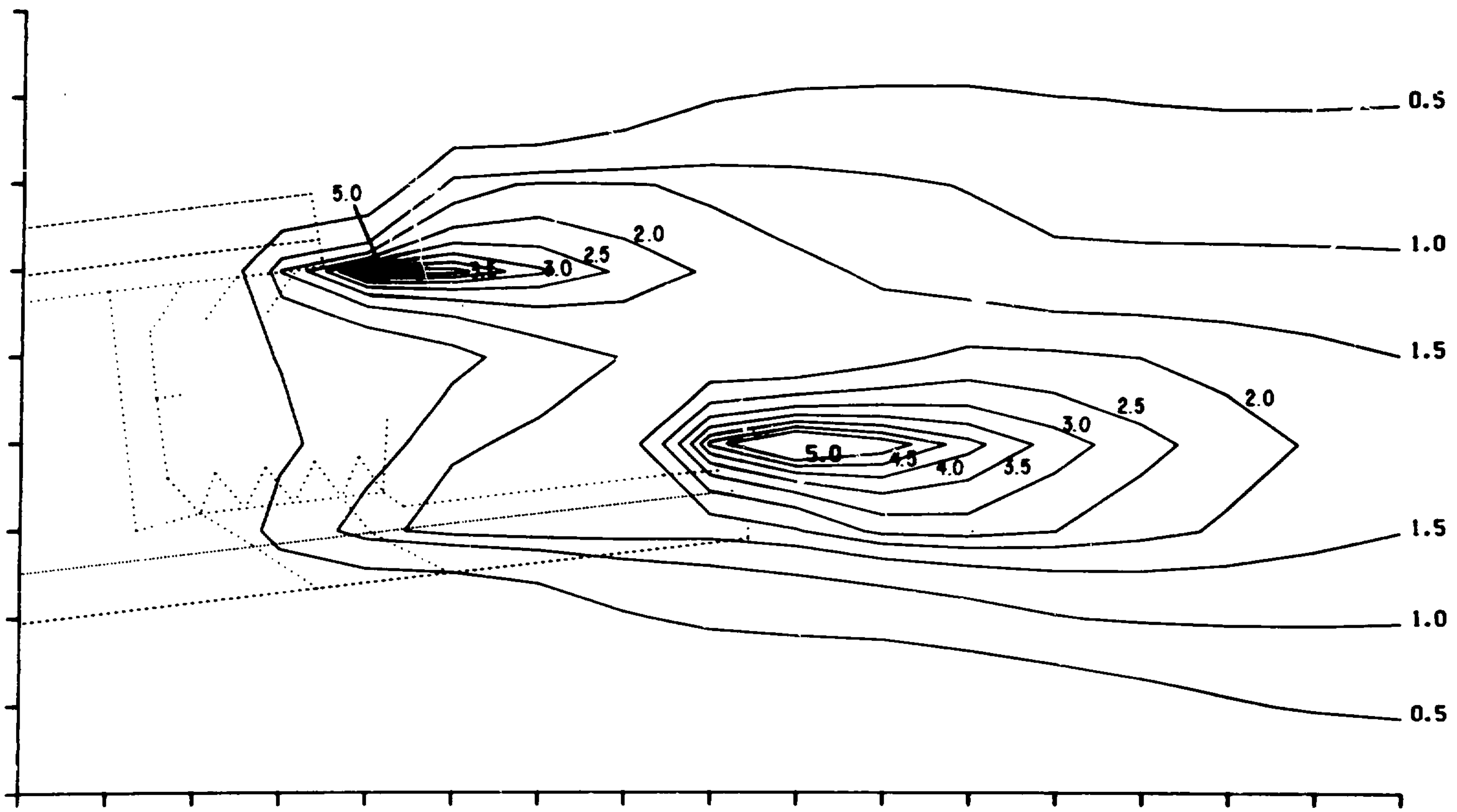

Figure 5b. THC Concentration Isopleths from Aircraft Operations at LAX for Hour 8 Assuming E Stability, a 350' Mixing Depth, and a 2 Knot Wind from the West (θ = 270°), Grid Size = 0.25 Miles

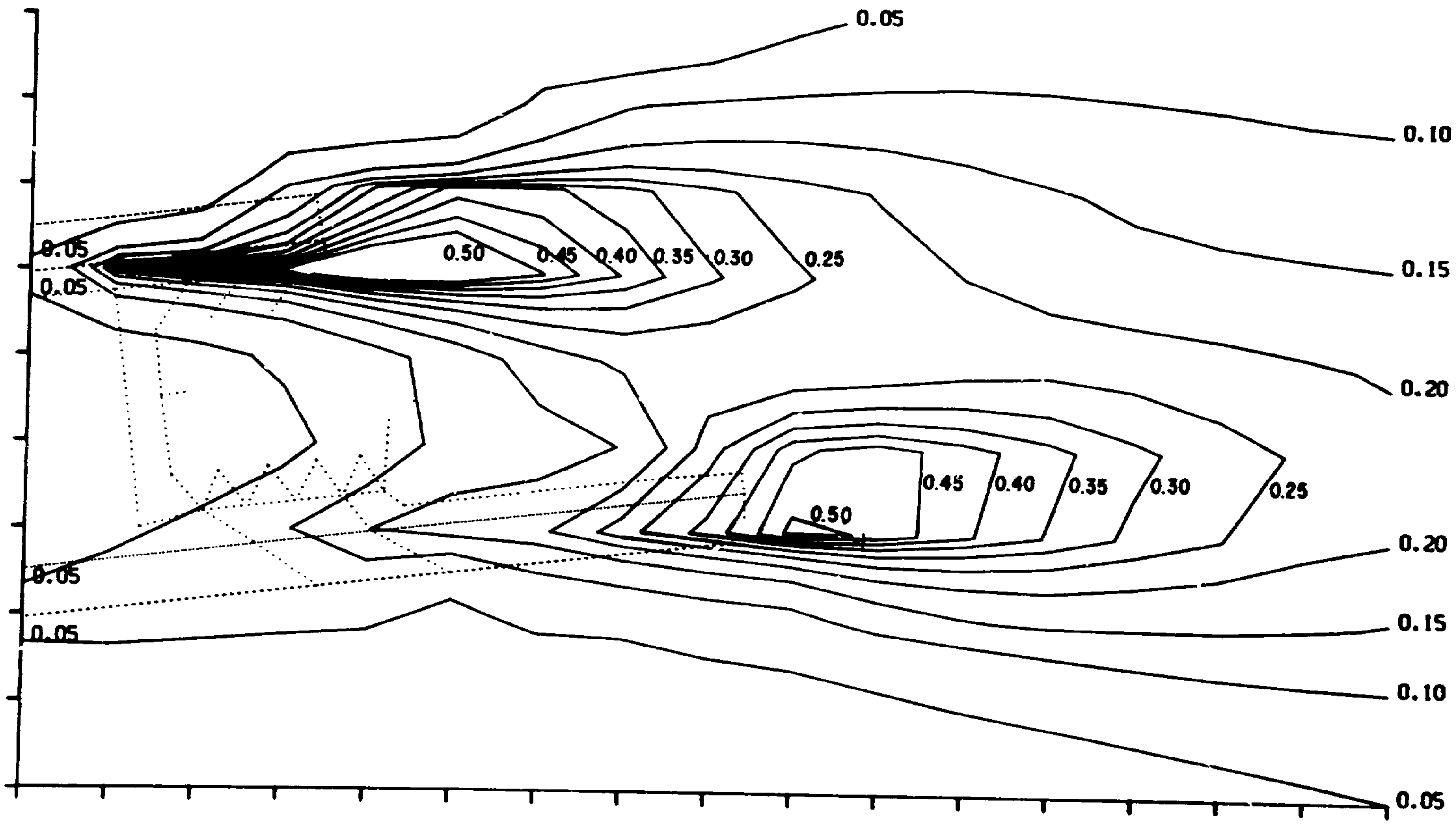

Figure 5c. NO_x Concentration Isopl=ths from Aircraft Operations at LAX for Hour 8 Assuming E Stability, a 350' Mixing Depth, and a 2 Knot Wind from the West (θ = 270°), Grid Size = 0.25 Miles

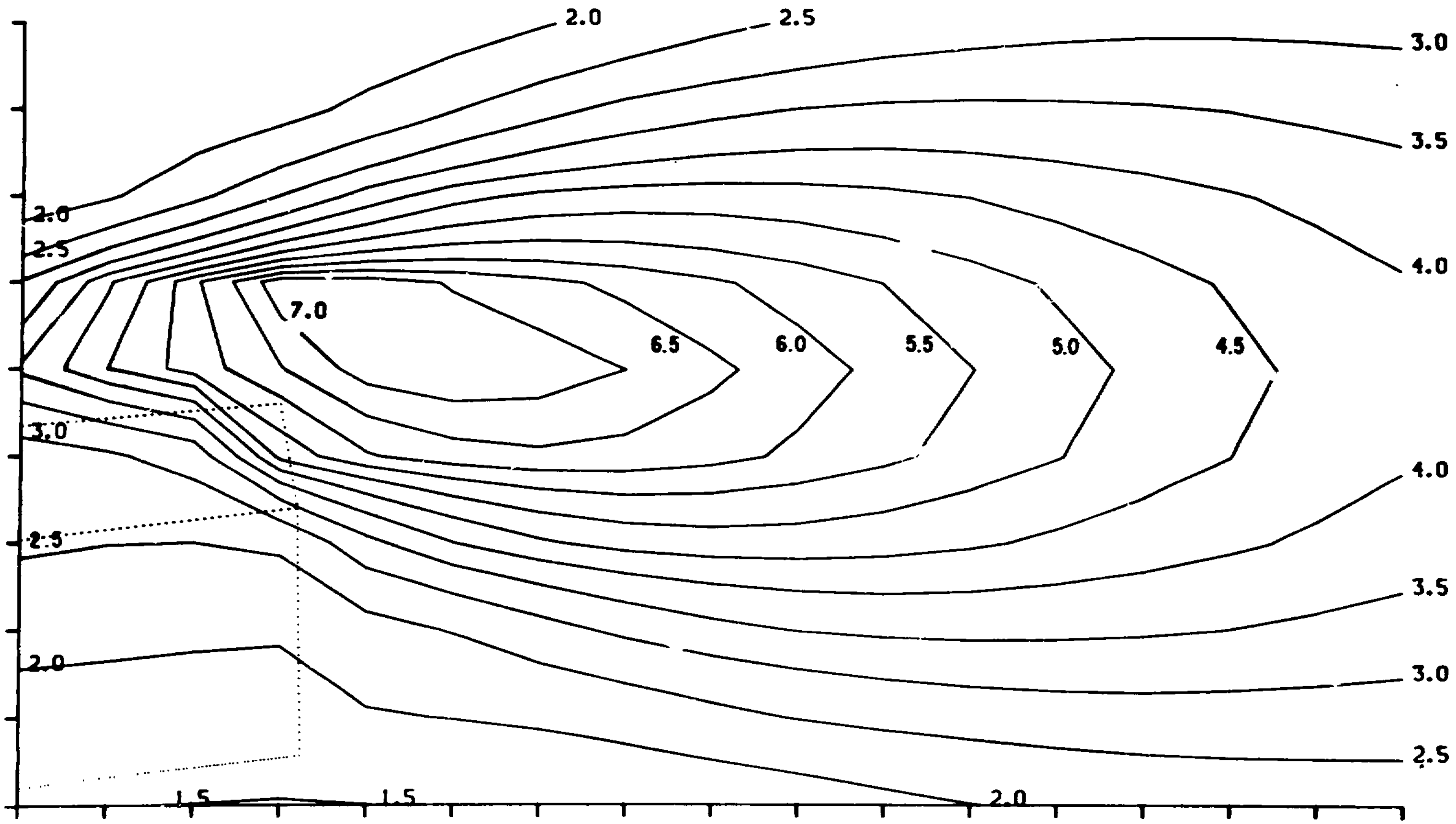

Figure 6a. CO Concentration Isopleths from Aircraft Operations at LAX for Hour 8 Assuming E Stability, a 350' Mixing Depth, and a 2 Knot Wind from the West ($\theta = 270°$), Grid Size = 0.05 Miles

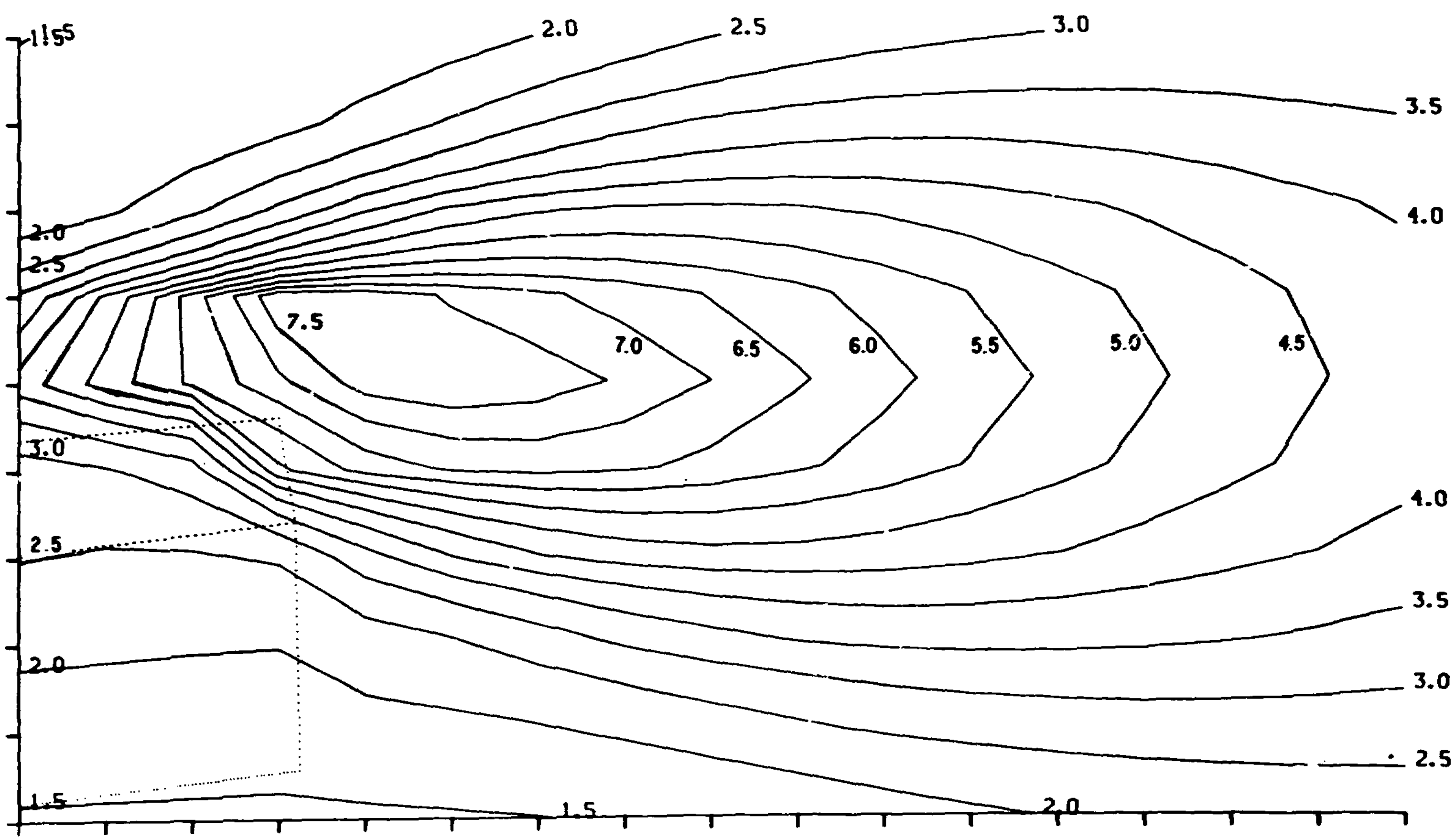

Figure 6b. THC Concentration Isopleths from Aircraft Operations at LAX for Hour 8 Assuming E Stability, a 350' Mixing Depth, and a 2 Knot Wind from the West (θ = 270°), Grid Size = 0.05 Miles

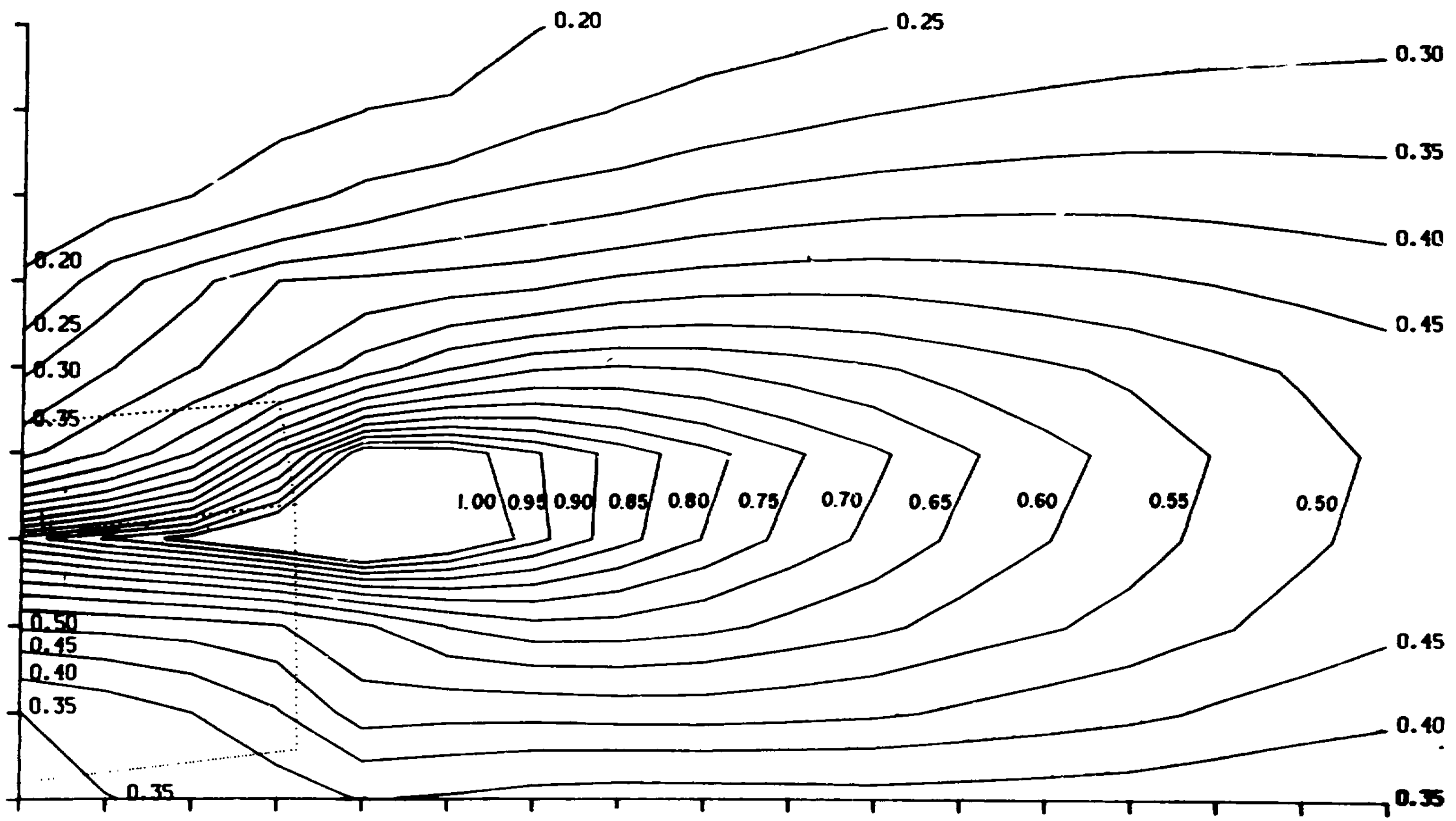

Figure 6c. NO_x Concentration Isopleths from Aircraft Operations at LAX for Hour 8 Assuming E Stability, a 350' Mixing Depth, and a 2 Knot Wind from the West (θ = 270°), Grid Size = 0.05 Miles

4.2 JOHN F. KENNEDY AIRPORT (JFK)

Figure 7 shows the hourly number of arrivals and departures at JFK on August 4, 1977. Looking at this diurnal cycle and considering the meteorological conditions during the day, hour 19 (1900-2000 EST) is the most likely "worst case" hour.

The assumed "worse-case" meteorological conditions for the selected "worst-case" hour are, E stability, a 350 ft mixing depth and a 2 knot wind direction 280°. In lieu of a separate meteorological study at this airport, the similarity between JFK and LAX in terms of land-sea interface suggests that these "worst-case" meteorological conditions may be appropriate for JFK.

The major aircraft line sources at JFK, including runways, taxiways, queueing areas, and terminal zone connectors are shown in Fig. 8. The grid spacing in this figure is 0.5 mile.

A 0.25 mile receptor grid was used in performing the AVAP calculations. Figure 9 shows the resulting concentration isopleths due to aircraft operations and Fig. 10 is the 3-dimensional representation of the concentration profiles. Table 8 lists the hour 19 aircraft emissions for each line source type.

As at LAX, maximum hourly average CO concentrations are low compared to the standards limit of 35 ppm (National Ambient Air quality Standards Limit). The hydrocarbon levels (>0.5 ppm) cover an area several times the airport area. These hydrocarbon concentrations of up to several ppm are high compared to the guideline and may increase oxidant problems in the vicinity of the airport. The NO_x values at locations of possible public exposure are of the same order of magnitude as the proposed hourly NO_2 standards of 0.2-0.5 ppm, again suggesting that a more detailed analysis of the NO, NO_2 concentrations should be conducted at airports.

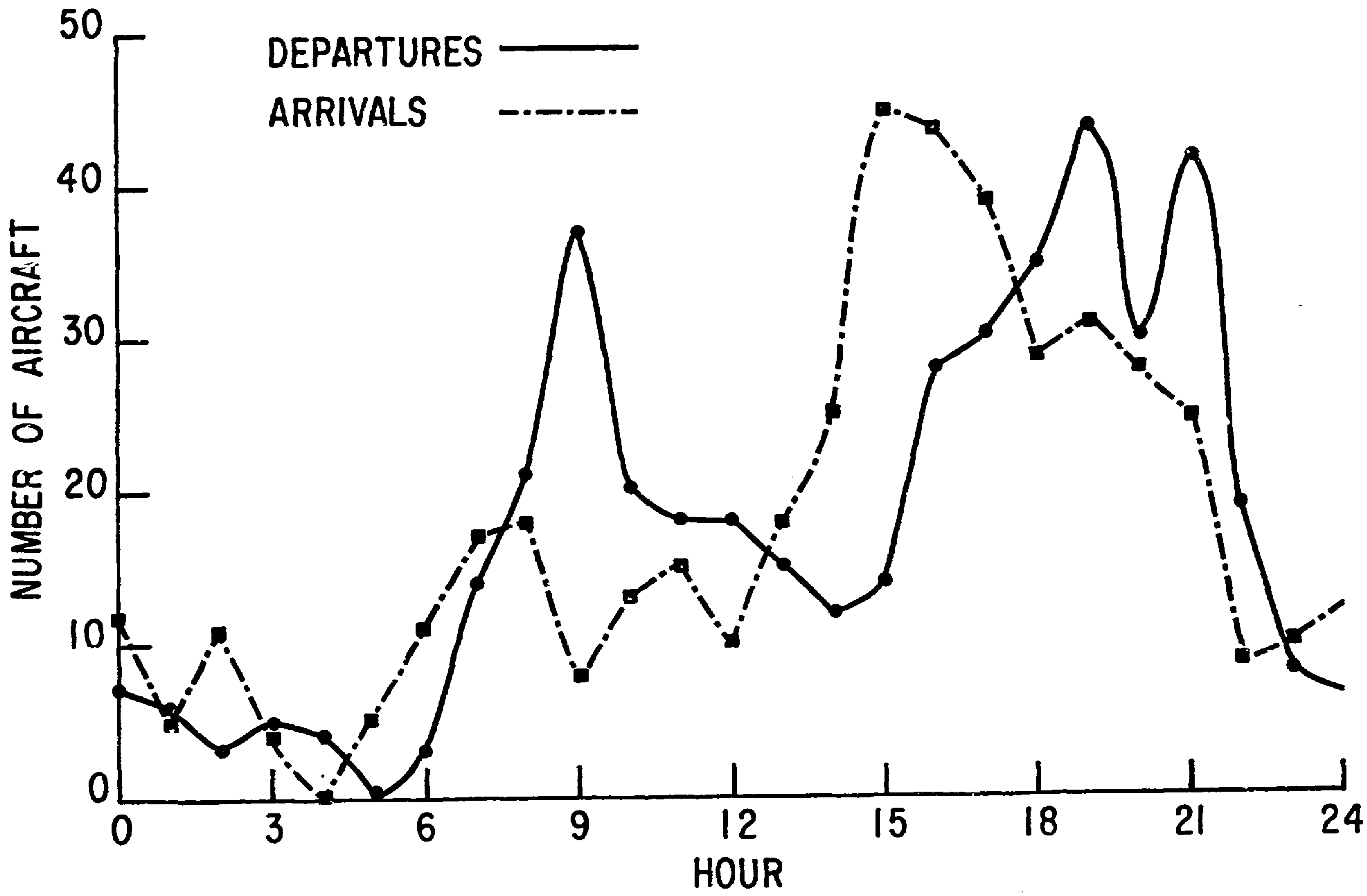

Figure 7. Hourly Number of Arrivals and Departures at JFK Versus Hour of the Day

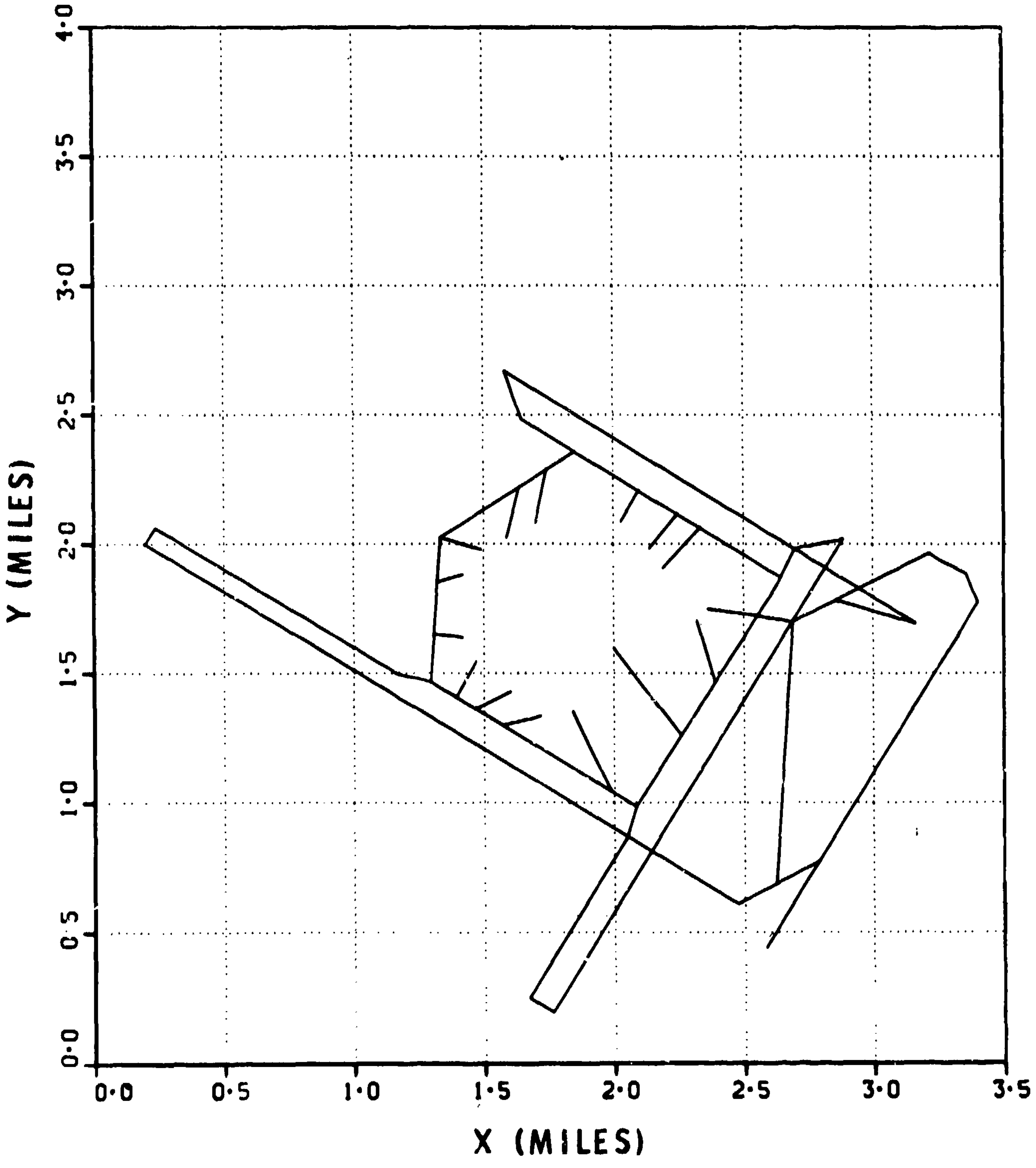

Figure 8. Map of Aircraf Line Sources at JFK

Table 8. Summary of Aircraft Emission for Hour 19 at JFK Airport

Location	Emissions (10^3 lbs)		
	CO	THC	NO_x
Runways	0.08	0.05	0.52
Taxiways	3.94	2.30	0.15
Queue	1.21	0.64	0.05
Terminal	0.60	0.28	0.04
Total on Ground	5.83	3.27	0.76
Approach and Climbout	0.28	0.04	0.88
Total	6.11	3.31	1.64

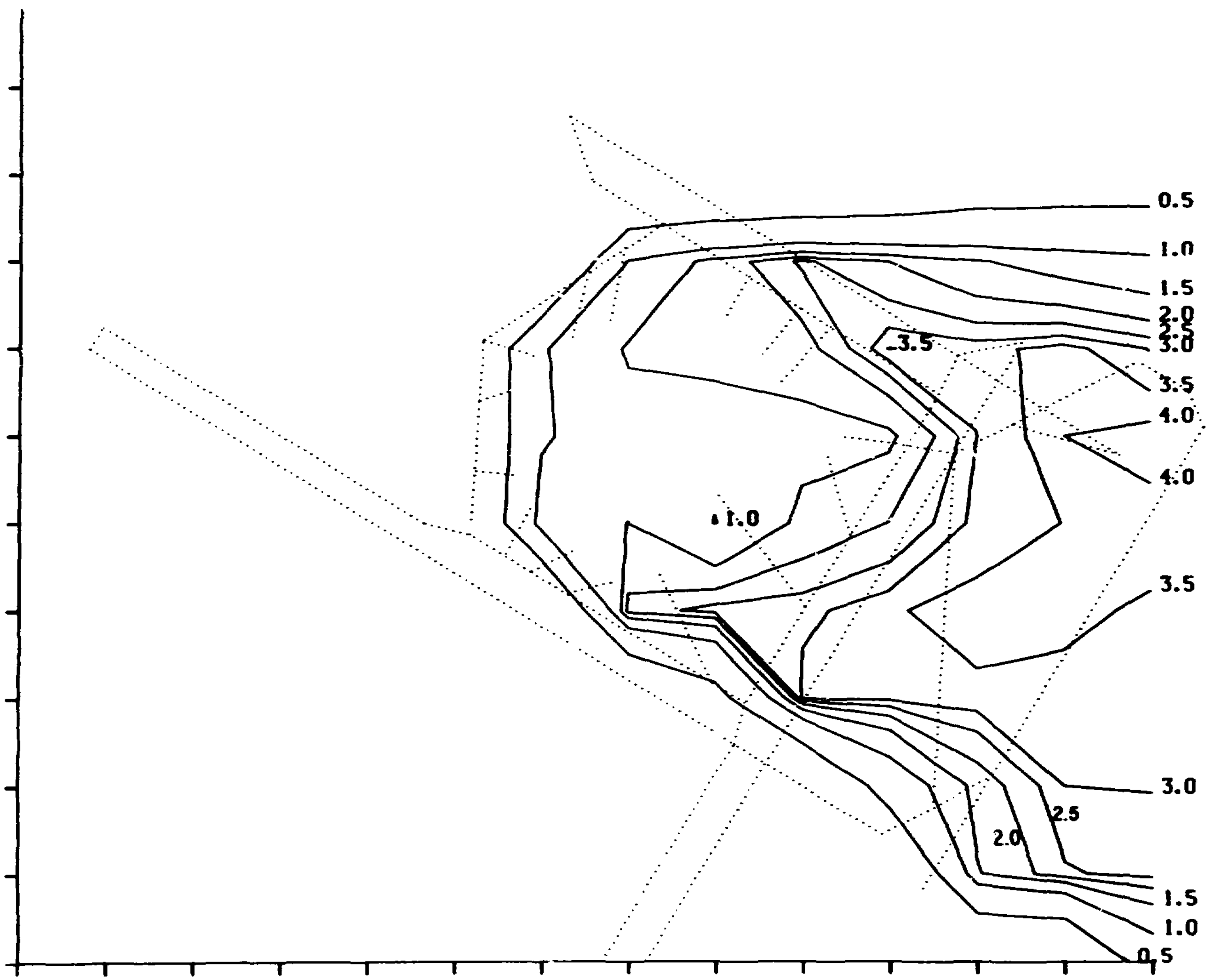

Figure 9a. CO Concentration Isopleths from Aircraft Operations at JFK for Hour 19 Assuming E Stability, a 350' Mixing Depth, and 2 knot Wind (θ = 280°). Grid Size = 0.25 miles.

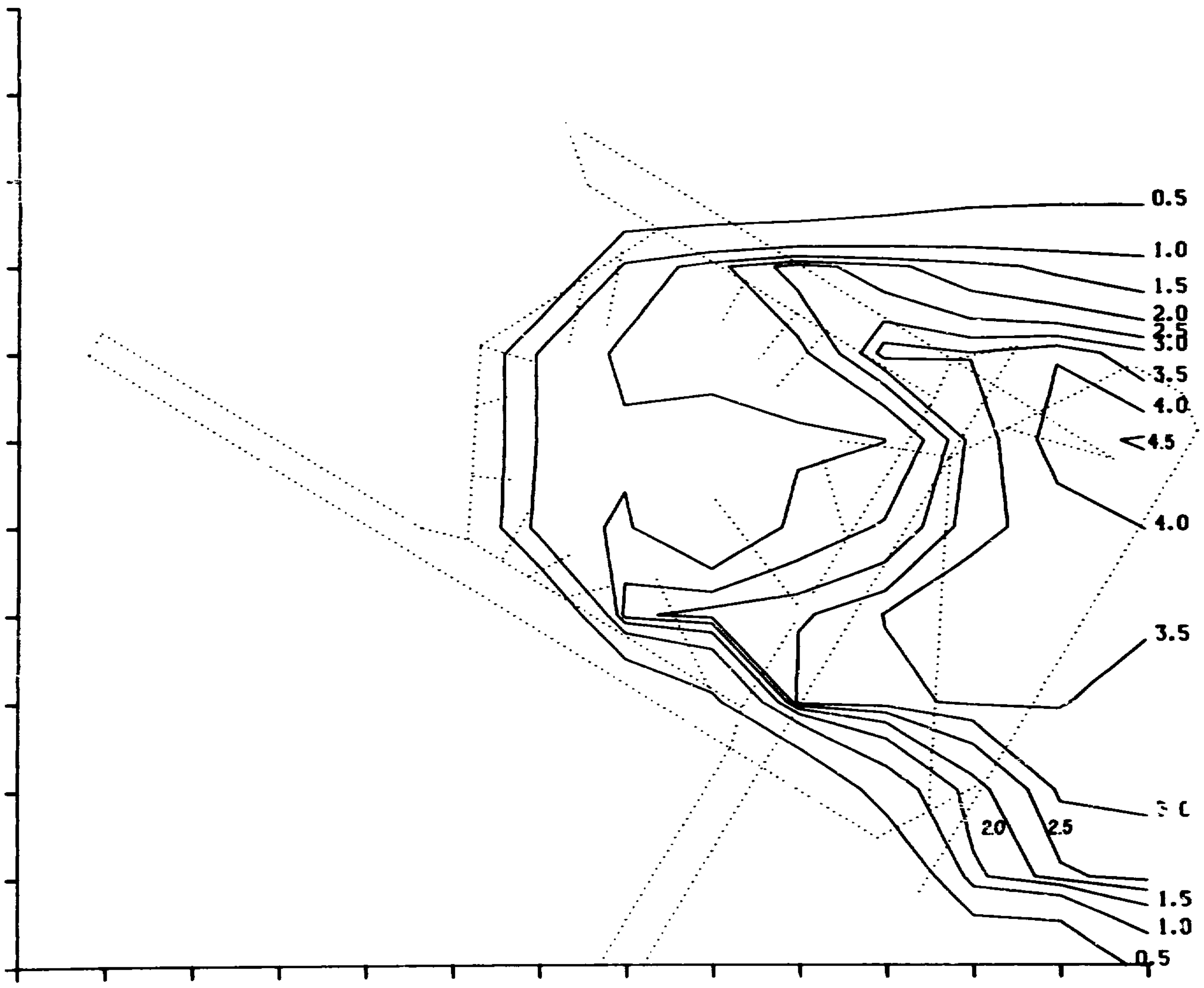

Figure 9b. THC Concentration Isopleths from Aircraft Operations at JFK for Hour 19 Assuming E Stability, a 350' Mixing Depth, and 2 knot Wind (θ = 280°). Grid Size = 0.25 miles.

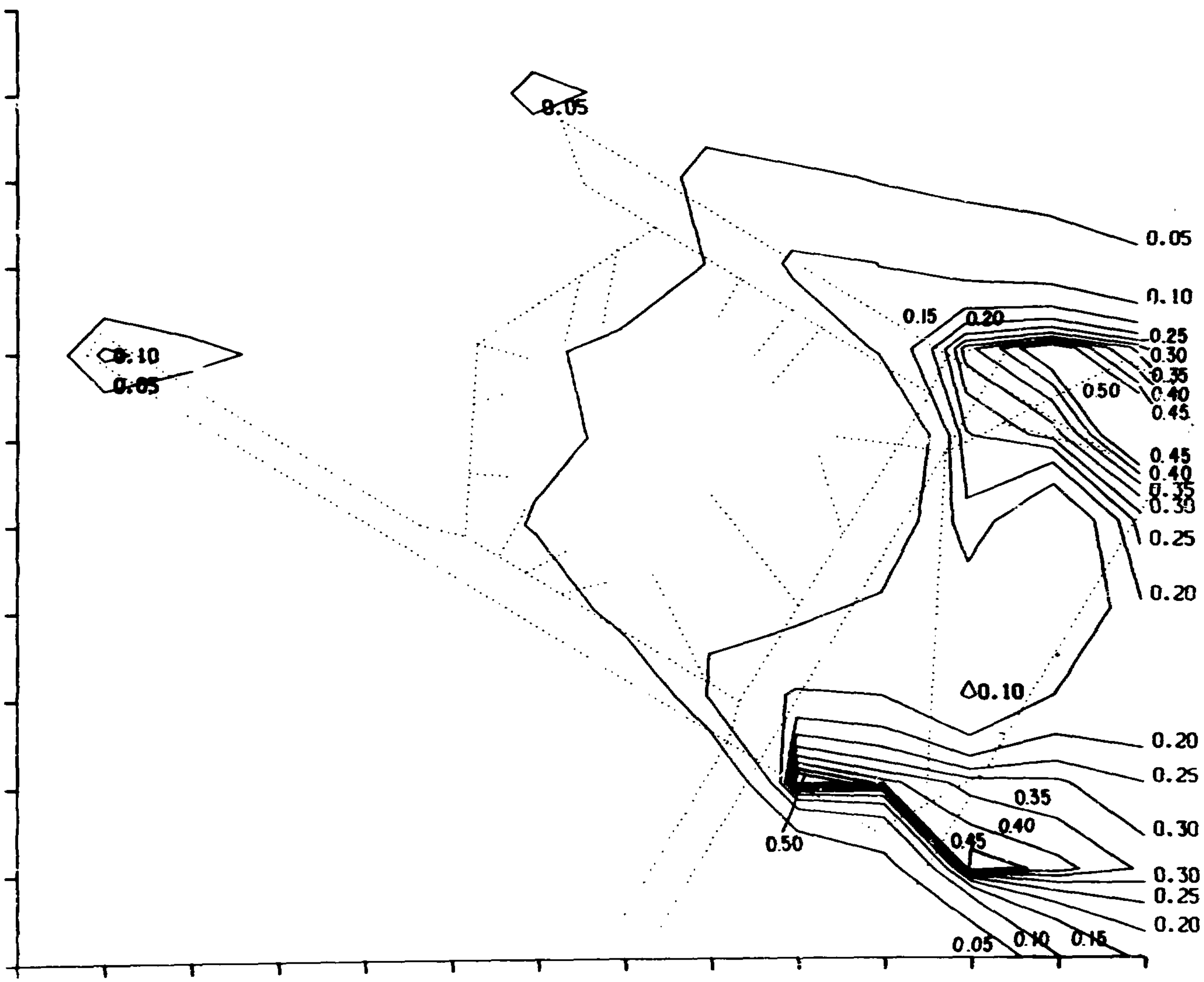

Figure 9c. NO_x Concentration Isopleths from Aircraft Operations at JFK for Hour 19 Assuming E Stability, a 350' Mixing Depth, and 2 knot Wind (6 = 280°). Grid Size = 0.25 miles.

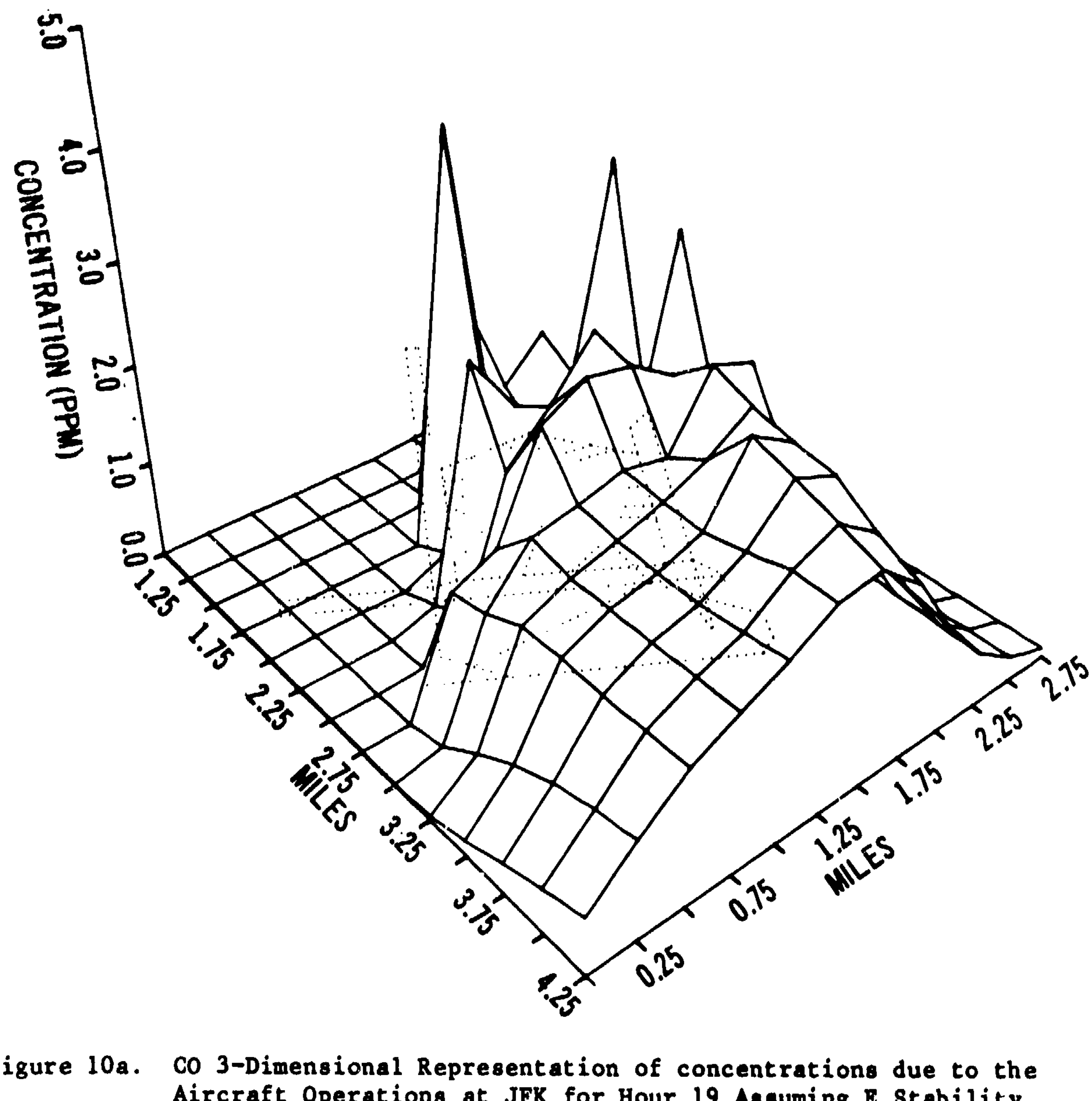

Figure 10a. CO 3-Dimensional Representation of concentrations due to the Aircraft Operations at JFK for Hour 19 Assuming E Stability, a 350' Mixing Depth, and a 2 knot Wind (= 280°), Grid Size = 0.25 miles. The time dependent vertical dispersion coefficients were used in this computation.

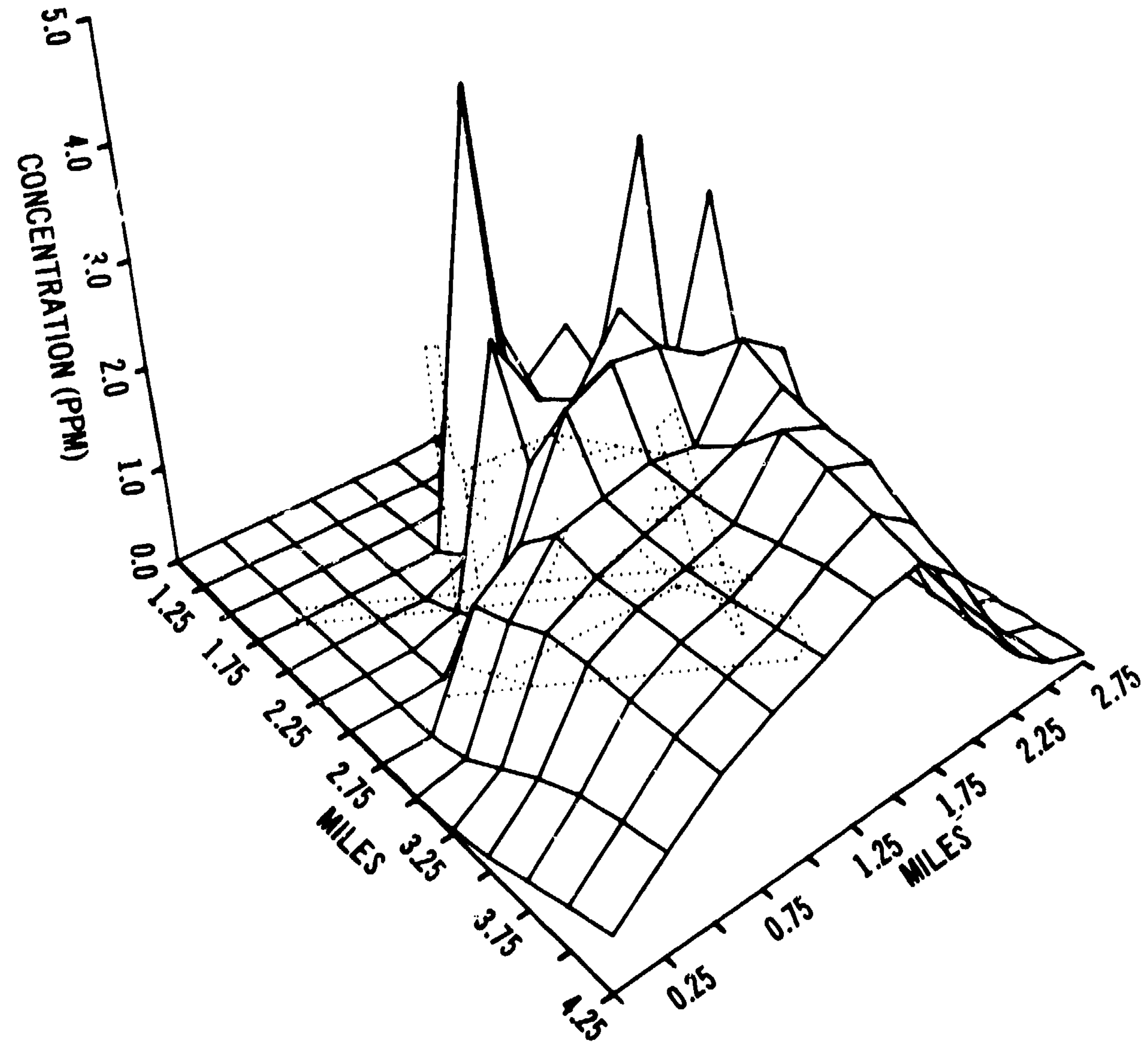

Figure 10b. THC 3-Dimensional Representation of concentrations due to the Aircraft Operations at JFK for Hour 19 Assuming E Stability, a 350' Mixing Depth, and a 2 knot Wind (= 280°), Grid Size = 0.25 miles. The time dependent vertical dispersion coefficients were used in this computation.

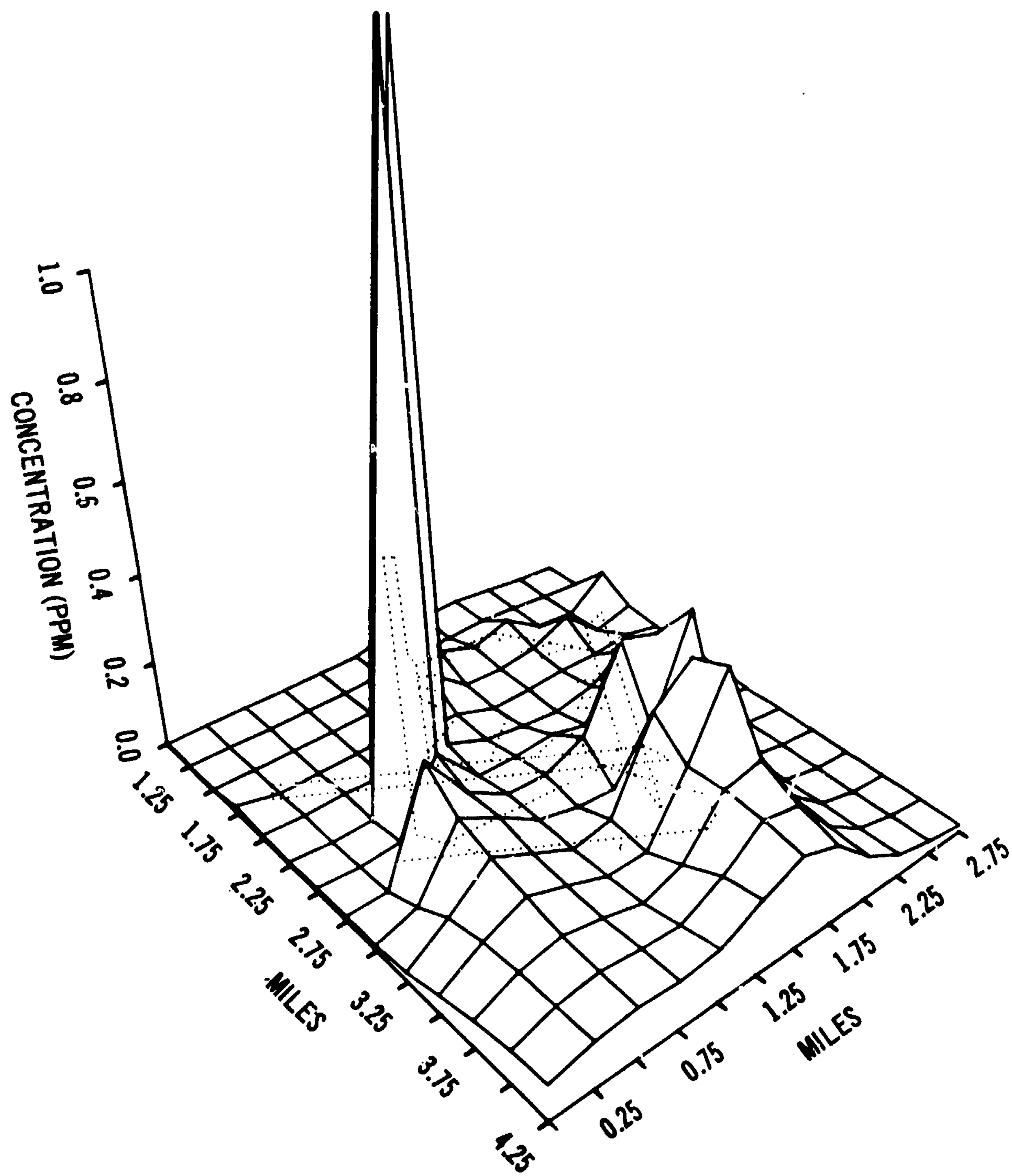

Figure 10c. NO_x 3-Dimensional Representation of concentrations due to the Aircraft Operations at JFK for Hour 19 Assuming E Stability, a 350' Mixing Depth, and a 2 knot Wind (= 280°), Grid Size = 0.25 miles. The time dependent vertical dispersion coefficients were used in this computation.

4.3 O'HARE INTERNATIONAL AIRPORT (ORD)

Figure 11 shows the hourly number of arrivals and departures at ORD on August 4, 1977. Almost every hour between 7 and 18 could be a possible "worst case" hour. However, meteorological considerations rule out most of the hours. Hour 8 is selected because it is probably the last hour having early morning meteorological conditions that could potentially lead to considerable air pollution.

As discussed in Volume 1, Section 2.3 and assumed for LAX and JFK, the assumed meteorological conditions for the "worst case" hour 8 (0800-0900 CDT) are assumed to consist of E stability, a 350 feet mixing depth, and a 2 knot wind. The aircraft emissions for hour 8 are listed by line source type in Table 9. Figure 12 shows a map of the major aircraft line sources at ORD including runways, taxiways, queueing segments and terminal zone connectors. The grid spacing of Fig. 8 is 0.5 mile.

AVAP calculations were done using a 0.25 mile receptor grid. Two cases were computed. One with a 45° wind (Figs. 13 and 15), and one using a 135° wind (Figs. 14 and 16). Both of the cases showed similar results. The CO concentrations are found to be low compared to the National Ambient Air Quality Standard of 35 ppm. The hydrocarbon levels reach a peak value in excess of 5 ppm and concentrations exceeding 0.5 ppm cover an area several times the airport area. Therefore, as at LAX and JFK, hydrocarbon emissions caused by aircraft may exacerbate oxidant problems at and around the airport. The NO_x values again fall in the same range as the proposed hourly NO_2 standard of 0.2-0.5 ppm.

In all cases one can clearly see two peak values on the isopleth maps. Each of these peaks is located at the beginning of one of the two most used runways at ORD. The high peaks are better seen on the 3-dimensional contour plots (Figs. 15 and 16).

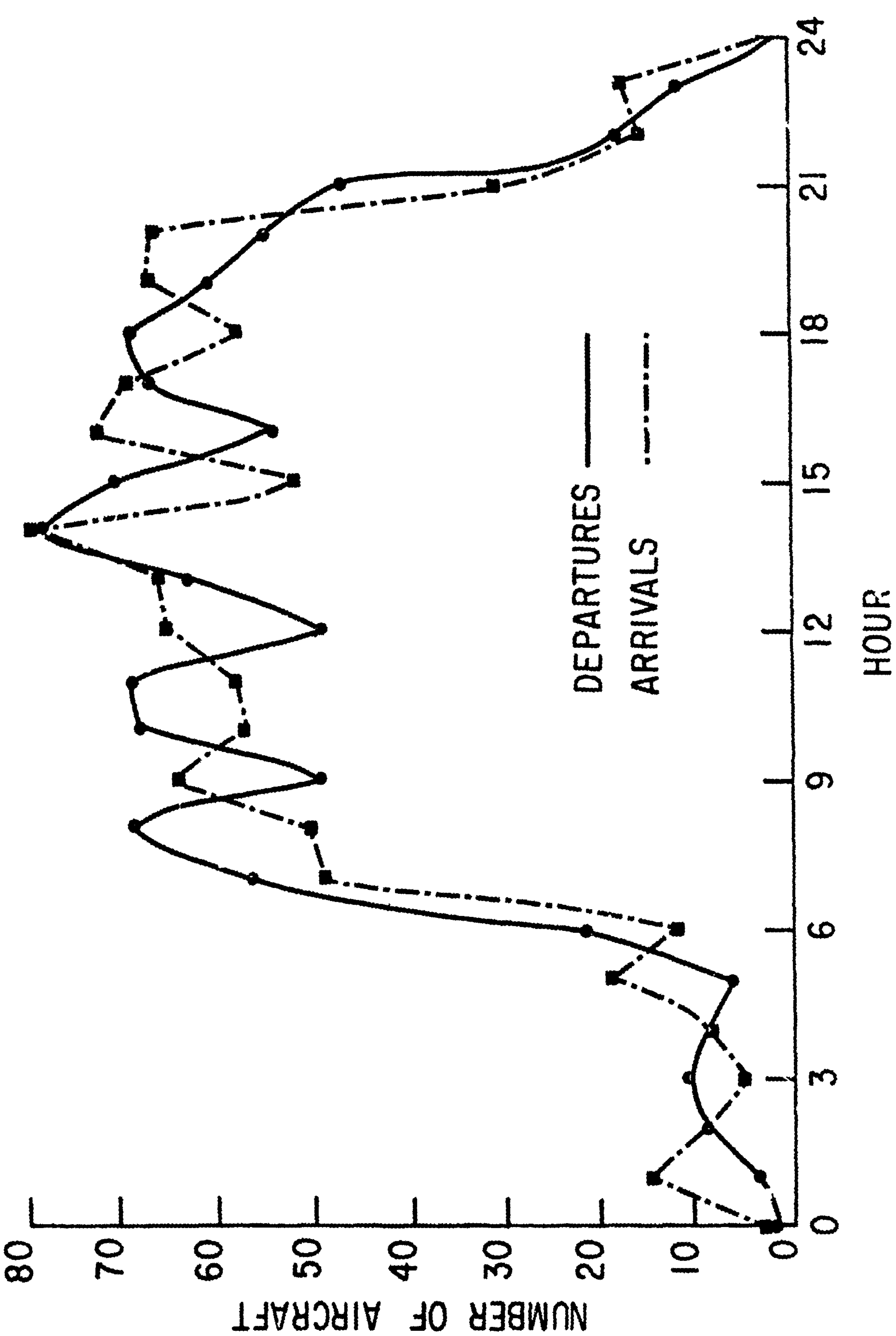

Figure 11. Hourly Number of Arrivals and Departures at ORD Versus Hour of the Day

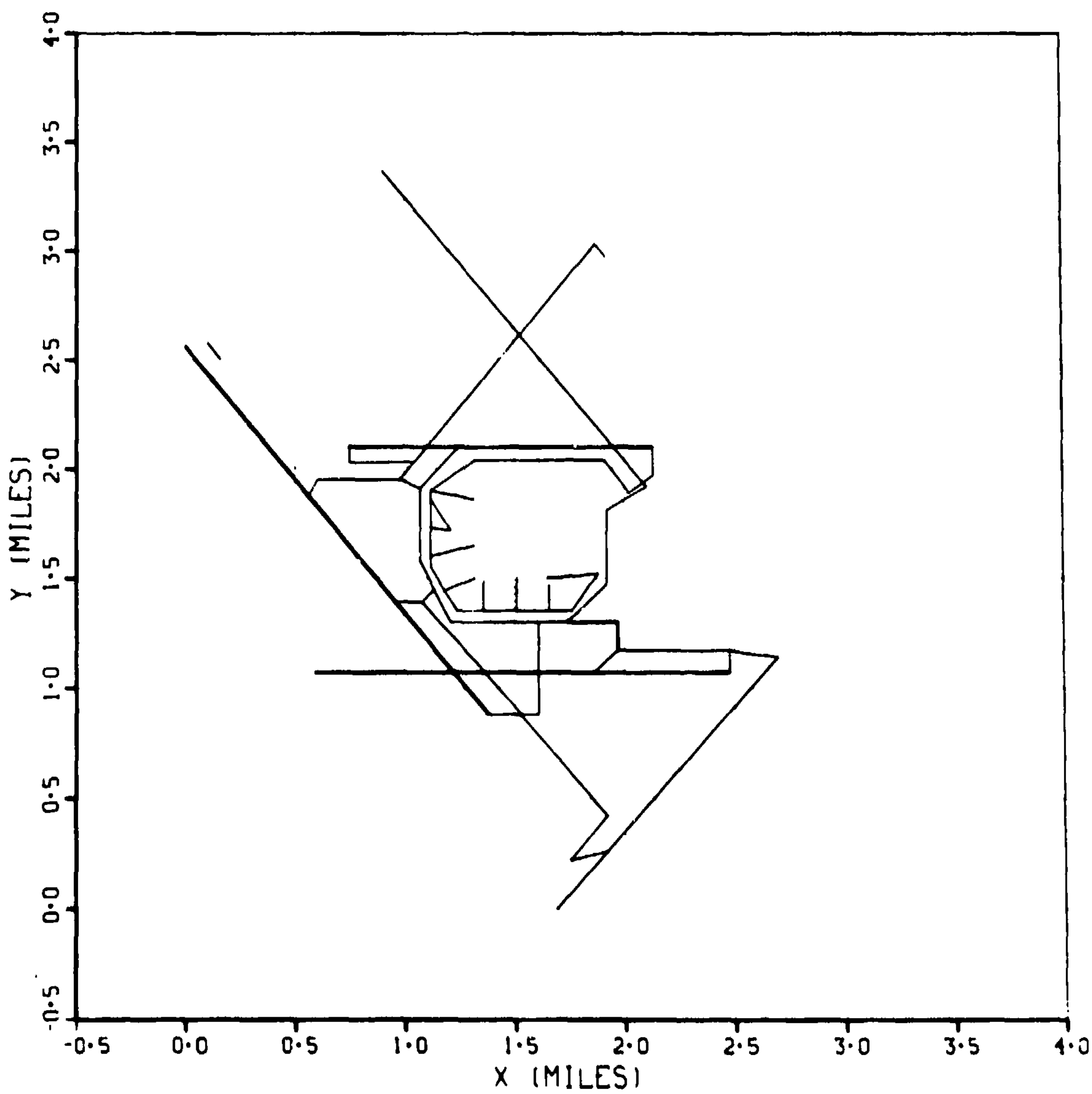

Figure 12. Map of Aircraft Line Sources at ORD

Table 9. Summary of Aircraft Emissions for Hour 8 at O'Hare International Airport

Location	Emissions (10^3 lbs) CO	THC	NO_x
Runways	0.07	0.03	0.46
Taxiways	1.68	0.90	0.10
Queue	2.11	1.13	0.12
Terminal	0.33	0.15	0.05
Total on Ground	4.19	2.21	0.73
Approach and Climbout	0.23	0.03	0.81
Total	4.42	2.24	1.54

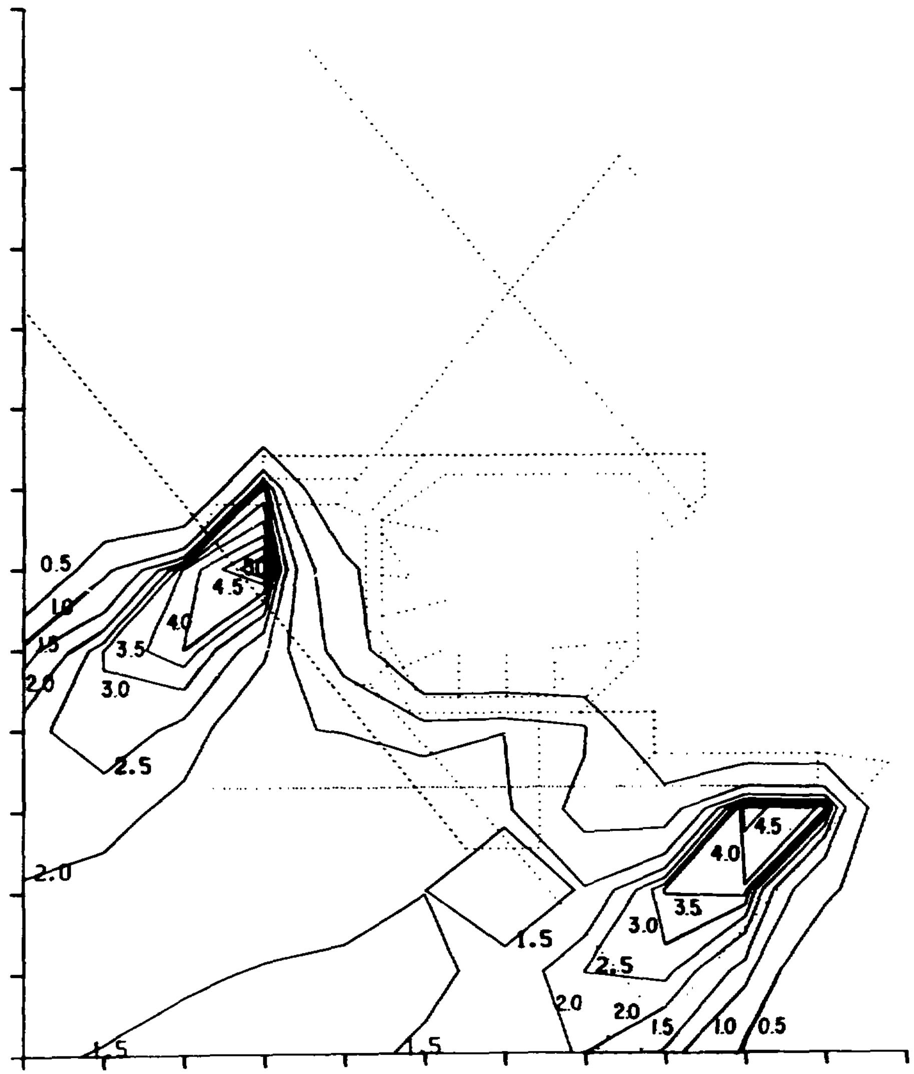

Figure 13a. CO Concentration Isopleths from Aircraft Operations at ORD for Hour 8 Assuming E stability, a 350' Mixing Depth, and a 2 knot Wind from the NE (θ = 45°). Grid Size = 0.25 miles.

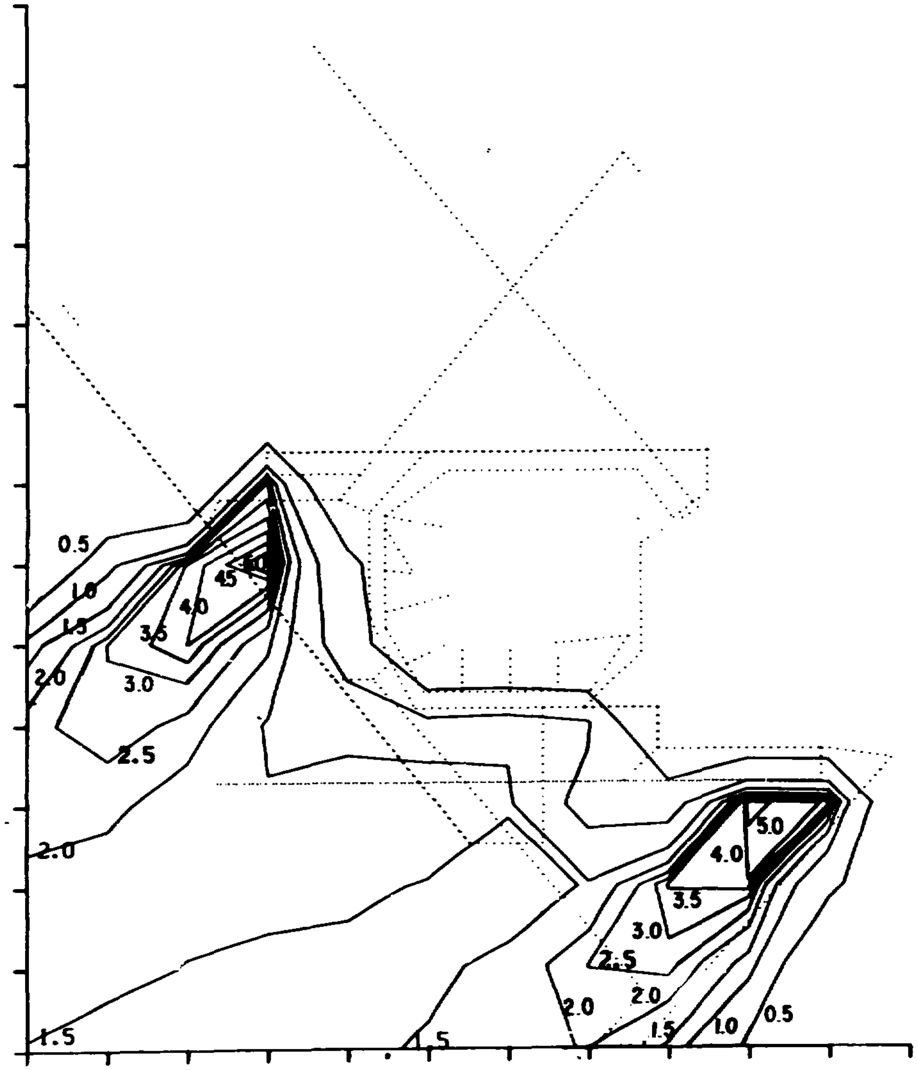

Figure 13b. THC Concentration Isopleths from Aircraft Operations at ORD for Hour 8 Assuming E stability, a 350' Mixing Depth, and a 2 knot Wind from the NE ($\theta = 45°$). Grid Size = 0.25 miles.

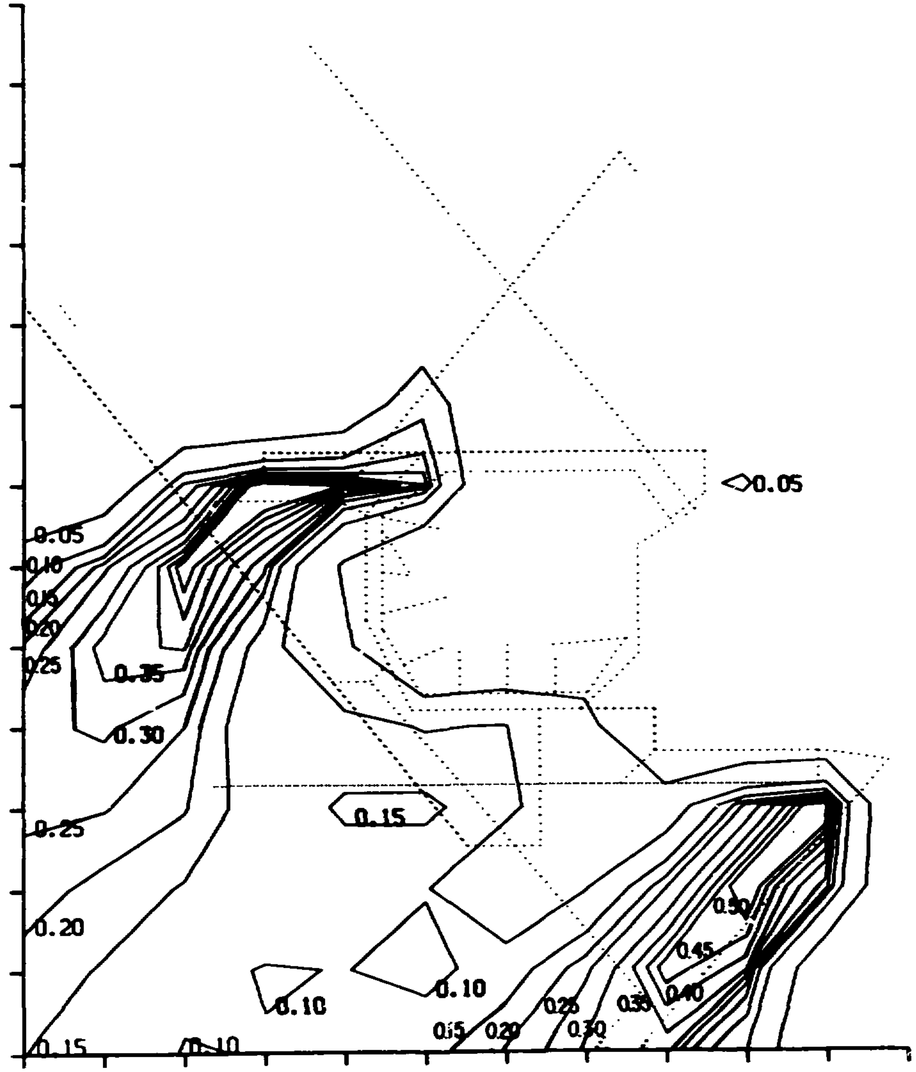

Figure 13c. NO_x Concentration Isopleths from Aircraft Operations at ORD for Hour 8 Assuming E stability, a 350' Mixing Depth, and a 2 knot Wind from the NE ($\theta = 45°$). Grid Size = 0.25 miles.

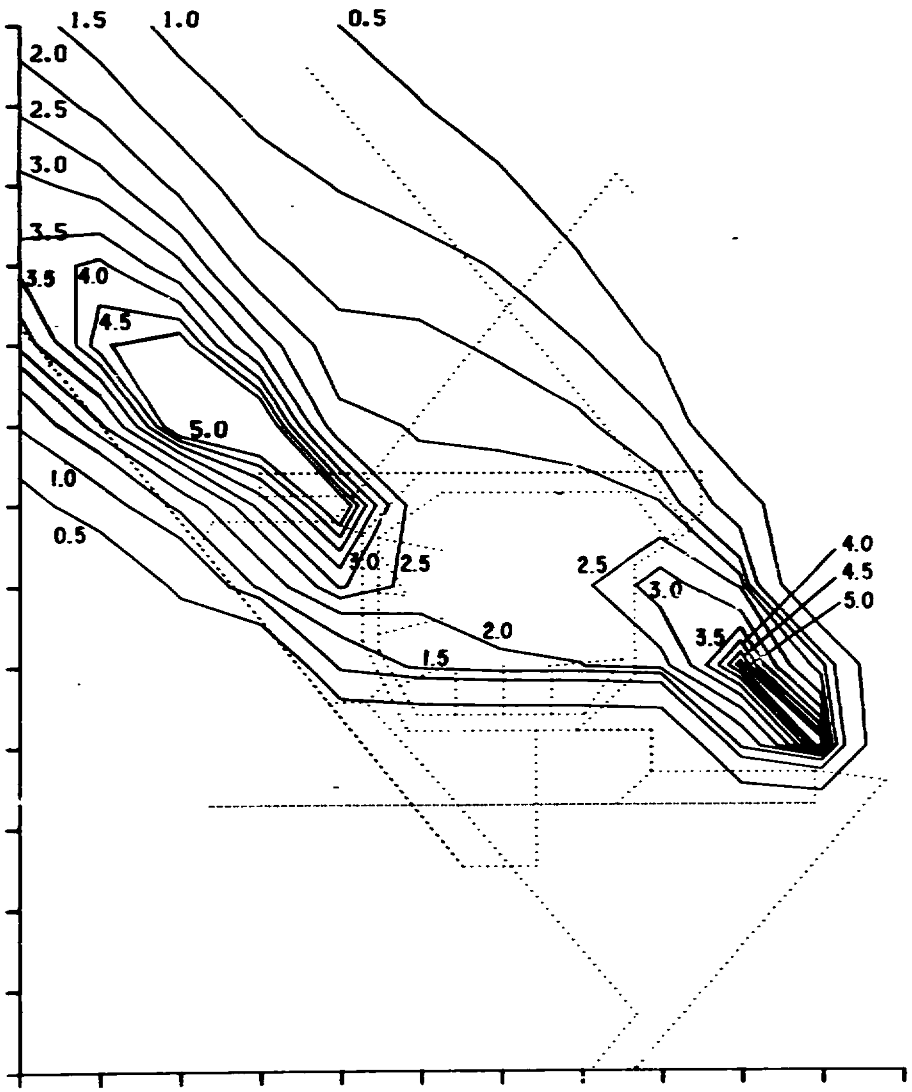

Figure 14a. CO Concentration Isopleths from Aircraft Operations at ORD for Hour 8 Assuming E stability, a 350' Mixing Depth, and a 2 knot Wind from the SE ($\theta = 135°$). Grid Size = 0.25 miles.

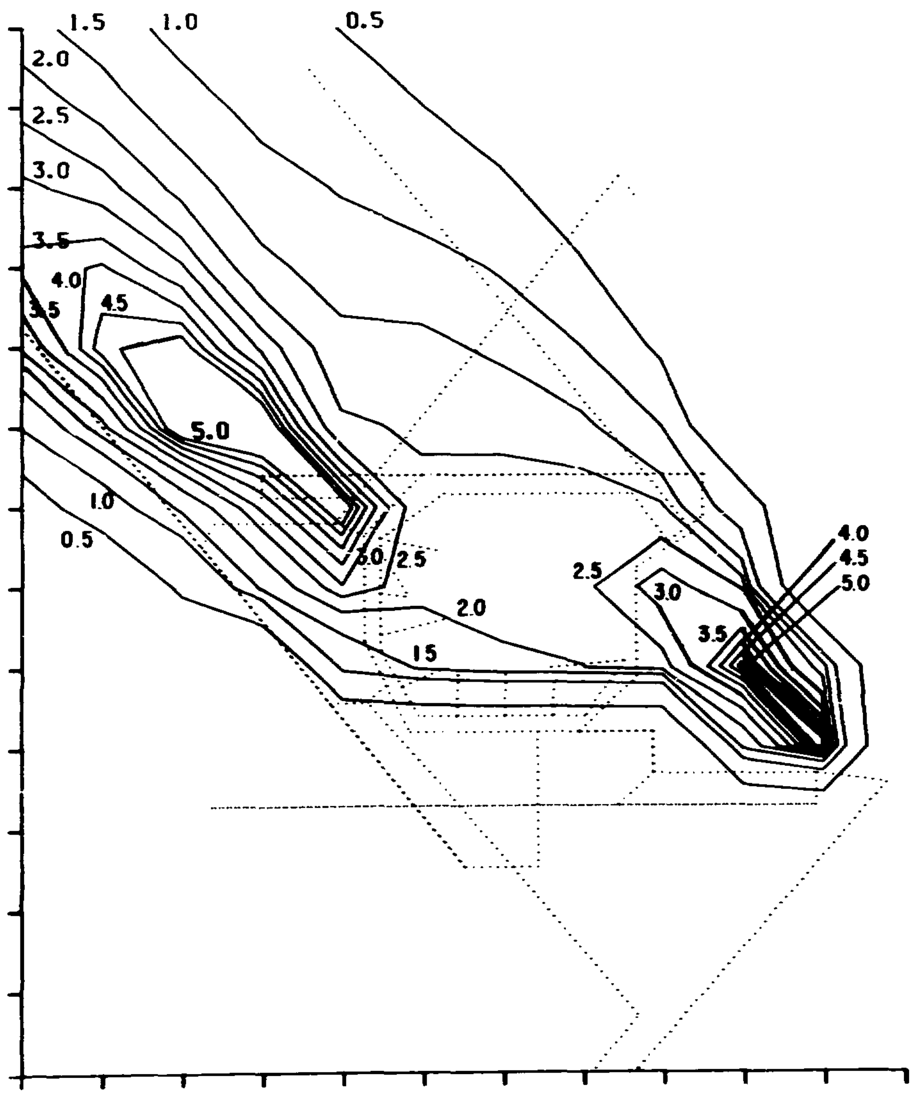

Figure 14b. THC Concentration Isopleths from Aircraft Operations at ORD for Hour 8 Assuming E stability, a 350' Mixing Depth, and a 2 knot Wind from the SE (θ = 135°). Grid Size = 0.25 miles.

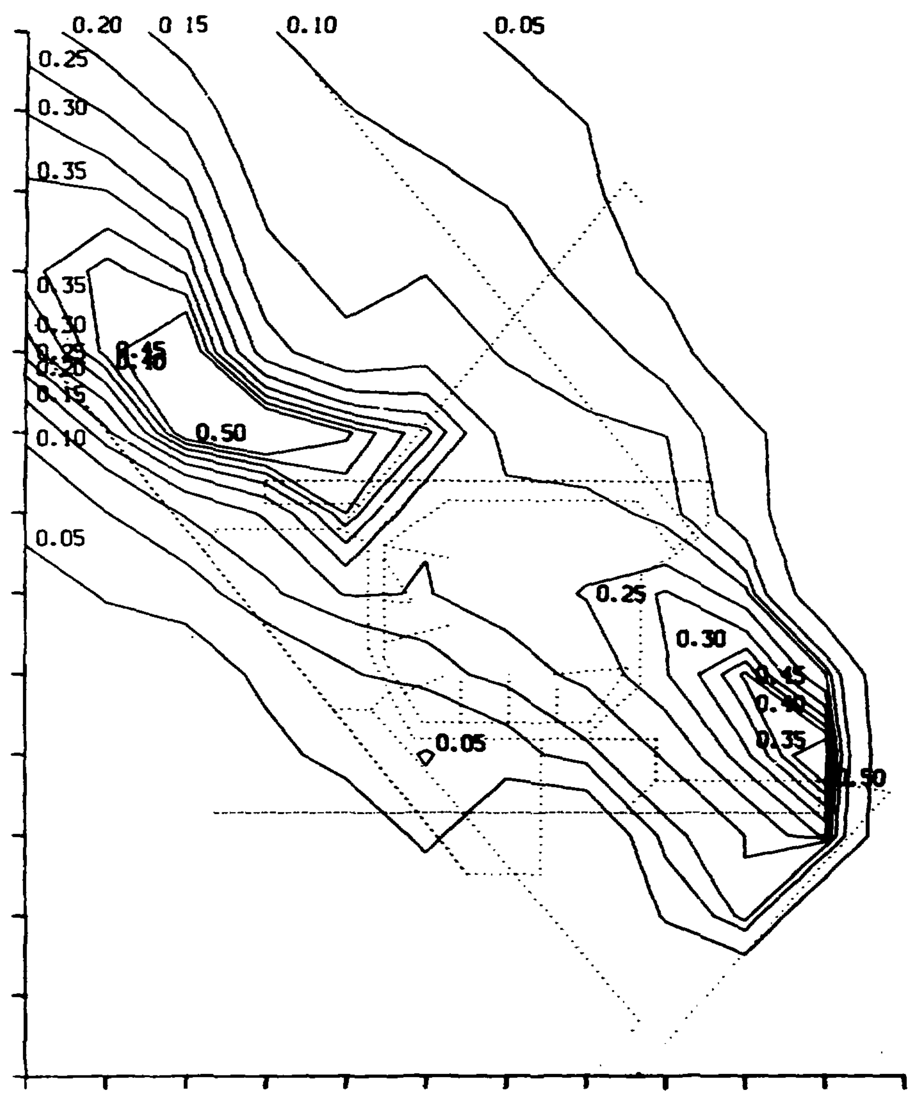

Figure 14c. NO_x Concentration *Isopleths from* Aircraft Operations at ORD for Hour 8 Assuming E stability, a 350' Mixing Depth, and a 2 knot Wind from the SE ($\theta = 135°$). Grid Size = 0.25 miles.

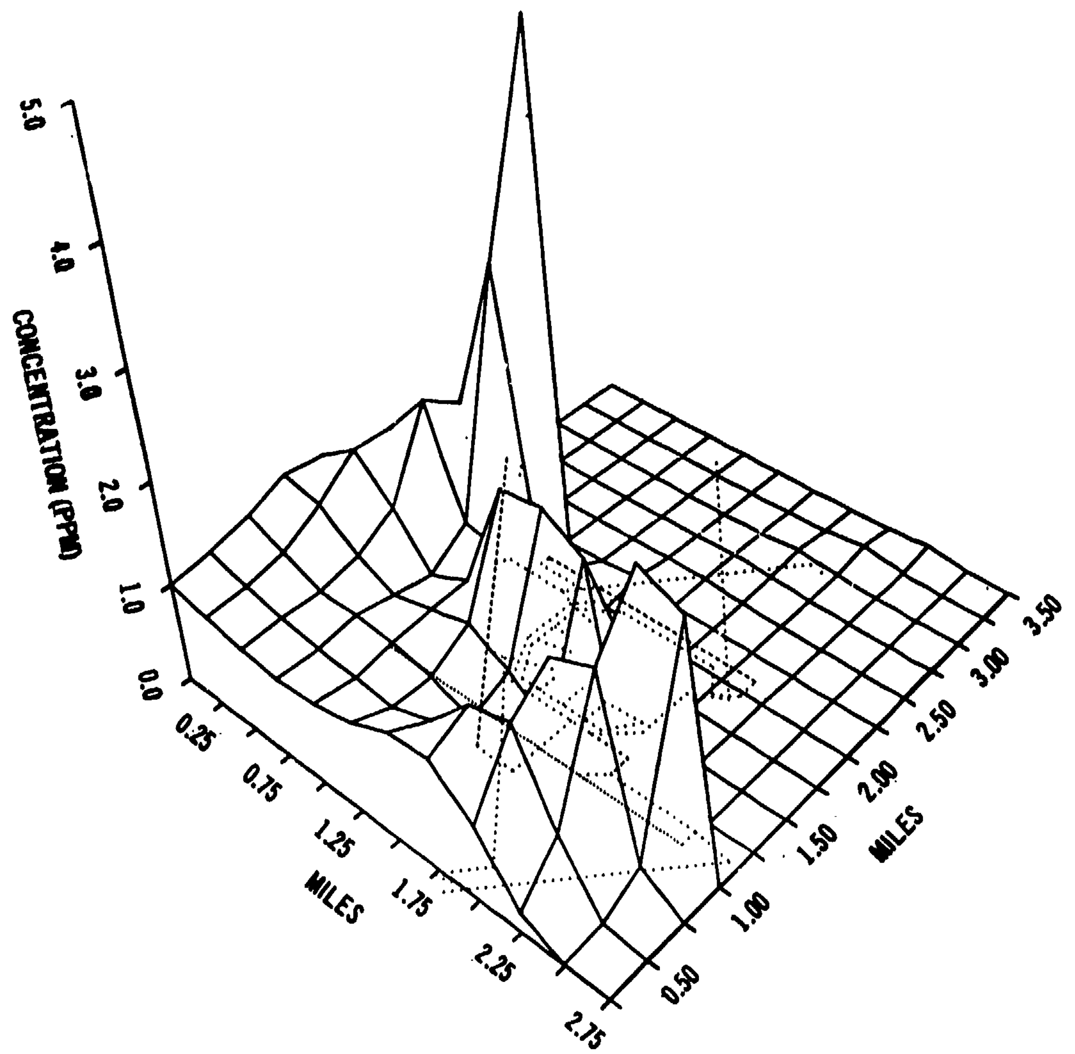

Figure 15a. CO 3-Dimensional Representation of pollutant concentrations due to the Aircraft Operations at ORD for Hour 8 Assuming E Stability, a 350' Mixing Depth, and a 2 knot Wind from the NE (= 45°). The time dependent vertical dispersion coefficients were used in this computation.

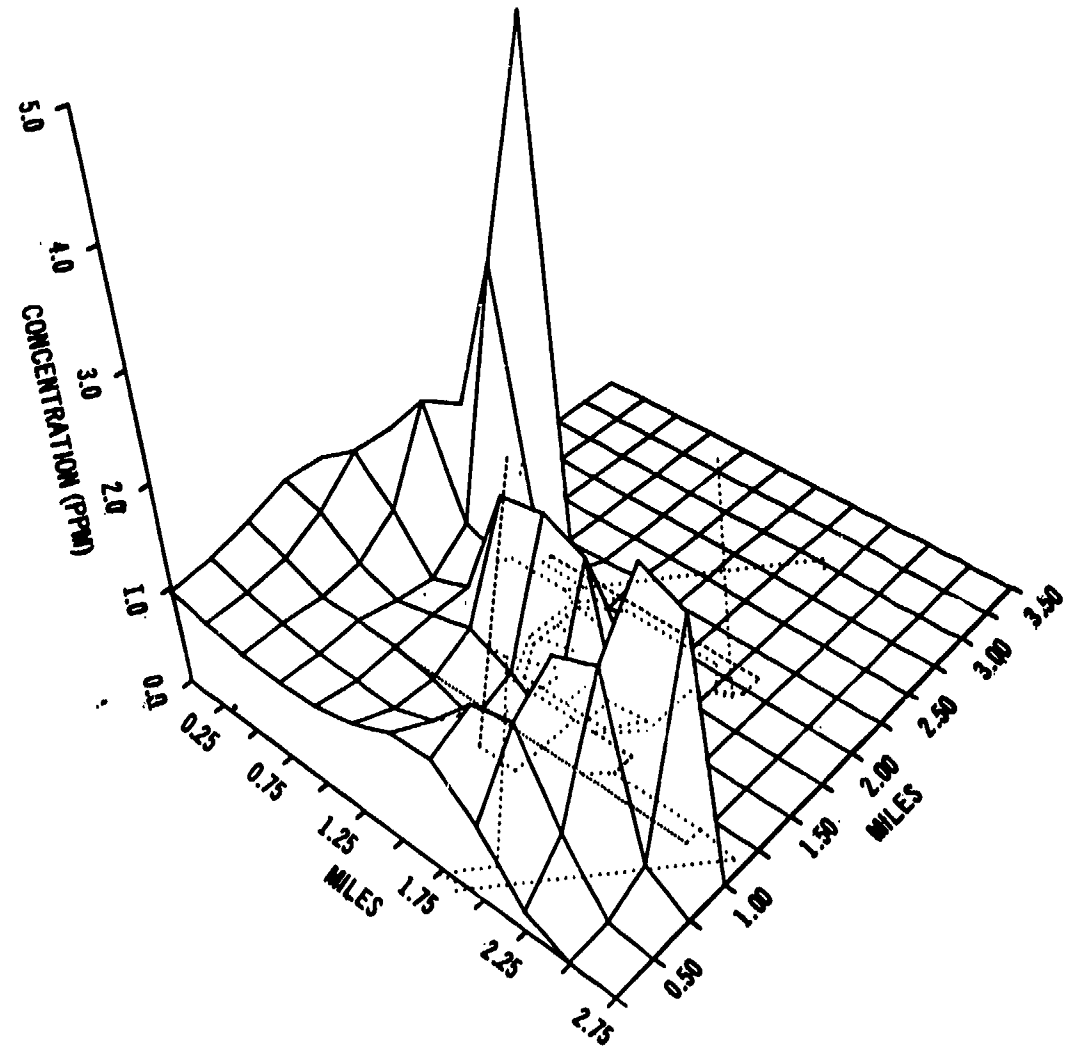

Figure 15b. THC 3-Dimensional Representation of pollutant concentrations due to the Aircraft Operations at ORD for Hour 8 Assuming E Stability, a 350' Mixing Depth, and a 2 knot Wind from the NE (= 45°). The time dependent vertical dispersion coefficients were used in this computation.

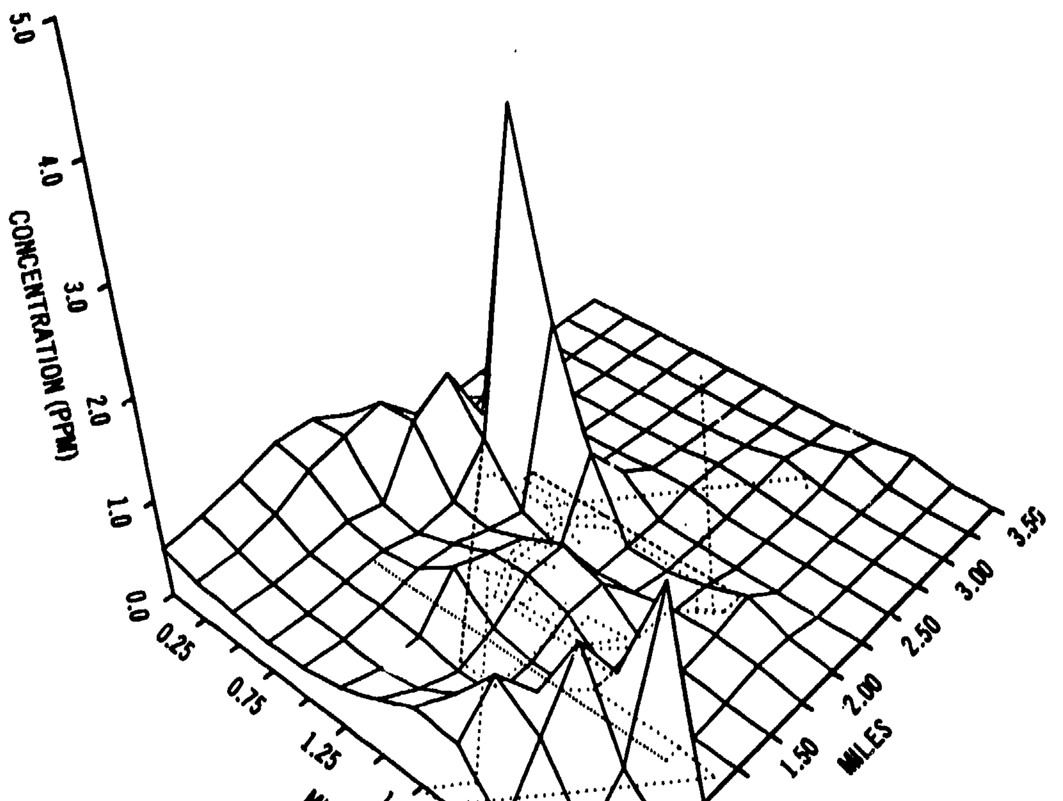

Figure 15c. NO_x 3-Dimensional Representation of pollutant concentrations due to the Aircraft Operations at ORD for Hour 8 Assuming E Stability, a 350' Mixing Depth, and a 2 knot Wind from the NE (= 45°). The time dependent vertical dispersion coefficients were used in this computation.

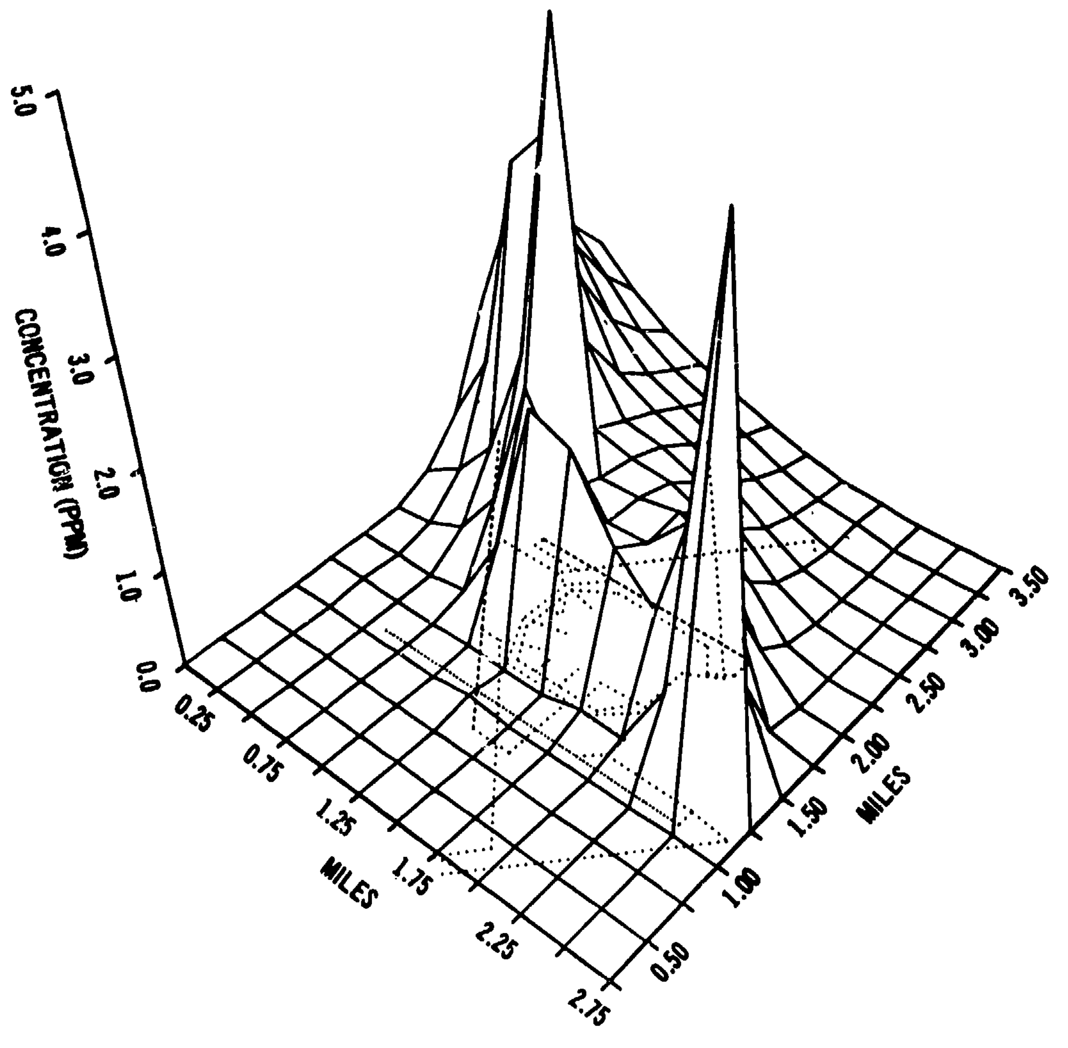

Figure 16a. CO 3-Dimensional Representation of pollutant concentrations due to the Aircraft Operations at ORD for Hour 8. Assuming E Stability, a 350' Mixing Depth, and a 2 knot Wind from the SE (= 135°). The time dependent vertical dispersion coefficients were used in this computation.

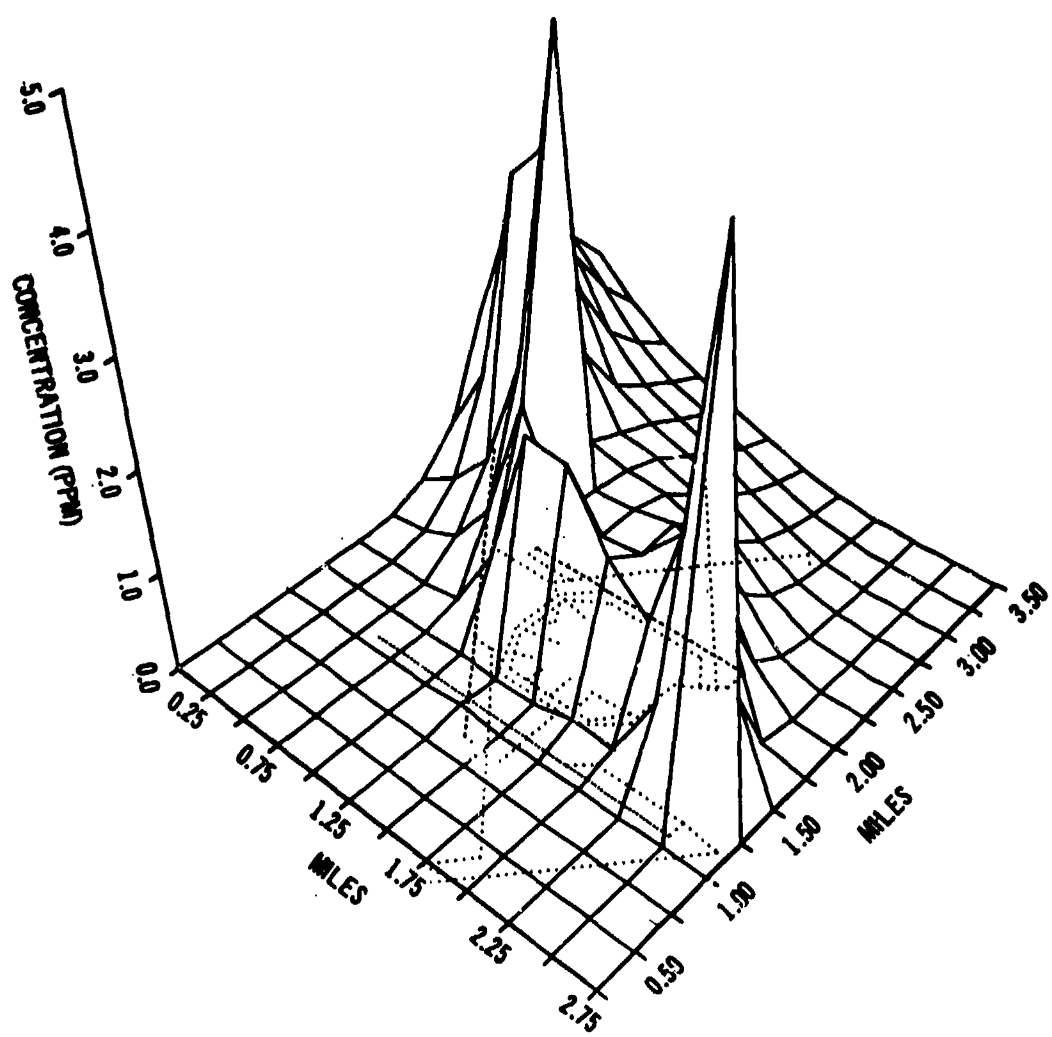

Figure 16b. THC 3-Dimensional Representation of pollutant concentrations due to the Aircraft Operations at ORD for Hour 8. Assuming E Stability, a 350' Mixing Depth, and a 2 knot Wind from the SE (= 135°). The time dependent vertical dispersion coefficients were used in this computation.

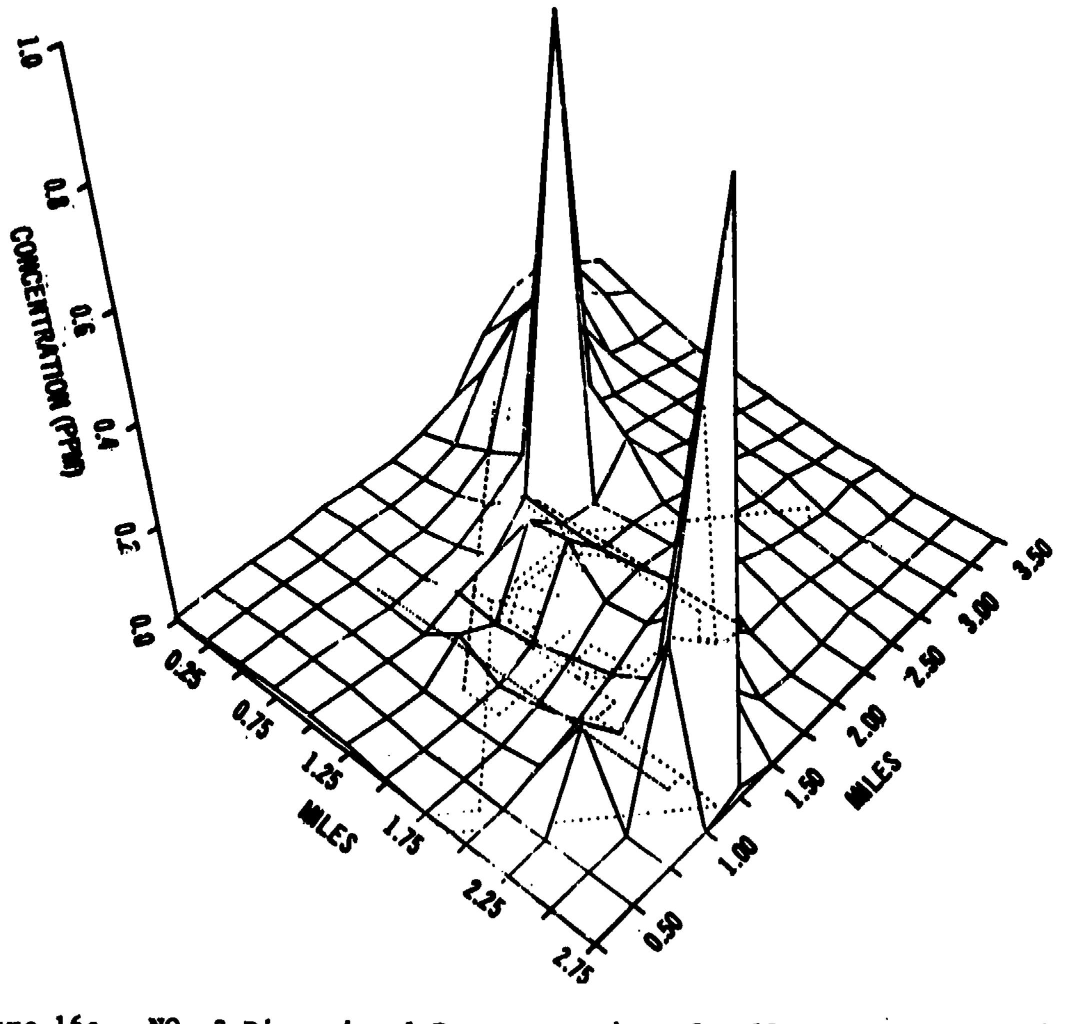

Figure 16c. NO_x 3-Dimensional Representation of pollutant concentrations due to the Aircraft Operations at ORD for Hour 8. Assuming E Stability, a 350' Mixing Depth, and a 2 knot Wind from the SE (= 135°). The time dependent vertical dispersion coefficients were used in this computation.

5 CONCLUSIONS

AVAP simulations of LAX, JFK, and ORD are consistent with each other in suggesting similar pollution levels and patterns at each of these major airports. Maximum CO concentrations, for example, are found adjacent to aircraft queueing areas but are limited to less than 10 ppm because of initial dilution related to engine induced turbulence and plume buoyancy. Despite the fact that peak CO emissions at JFK are double those at LAX, this initial dilution coupled with the physical and operational limitations on the aggregation of aircraft, results in peak CO levels at JFK being no higher than those at LAX. Thus, these simulations indicate that peak concentrations are quite airport independent. Closer analysis of each airport indicates that the peak concentrations of CO, HC, and NO_x are found adjacent to each busy queueing-runway complex and are not a function of the overall airport itself; thus, suggesting the hypothesis of "runway complex factorization". This hypothesis might be simply stated as: In the presence of well-separated queueing-runway complexes, peak concentrations are, to first order, only a function of the geometry of and activity on a particular queueing-runway complex.

Further conclusions based on visual analysis of the pollution contours at each of these airports include:

- Modeled hourly CO levels do not exceed 5 ppm at the terminal or at other areas of possible public exposure. This peak level is small compared to the NAAQS of 35 ppm.
- The close relationship between peak CO levels and the queueing of aircraft suggests that accurate modeling of the spatial distribution of aircraft in the queue is warranted. Future modeling should provide for a variable queue length, proportional to the number of queueing aircraft, rather than the fixed queue length presently assumed.
- Modeled HC levels, expressed as ppm, are nearly identical in magnitude and spatial location with the modeled CO levels for the fleet mixes considered at these airports.
- While peak HC levels are not presently the subject of health related standards, HC levels in excess of 0.25 ppm are considered to enhance oxidant formation. The area covered by this modeled 0.25 ppm contour is estimated (see also Vol. I, Fig. 1.6) to cover an area several times the airport area.
- Modeled hourly NO_x levels in excess of 0.5 ppm are indeed possible in areas of public exposure located downwind of the runway; however, detailed consideration of NO, NO_2, and O_3 photochemistry is necessary to assess maximum NO_2 levels that could result from the NO_x, primarily emitted as NO, from jet turbine engines.

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APPENDIX A

Description of the AVAP input decks
used in the calculations of ORD,
LAX and JFK.

The use of the AVAP model for simulation of aircraft impact on the air quality at and around airports requires detailed information. This appendix lists parts of the input needed for AVAP computations. For a complete input description see the "Airport Vicinity Air Pollution Model User's Guide" (AVAP) (3).

The tables presented here show the values used in the AVAP calculations for O'Hare International Airport (ORD), Los Angeles International Airport (LAX), and John F. Kennedy Airport (JFK).

Table A.1 shows the arrival and departure velocity, the take off time, the exhaust tail length, and the angle of approach and climbout. The values used for the three airports are the same except for the departure velocity at LAX.

Table A.2 lists the initial spreads of the aircraft line sources. The values are given in miles.

Table A.3 gives the initial terminal spread. Again, note the difference in the values used for LAX.

Table A.4 consists of taxi speed multiplier factors. These multipliers are relative to the taxi speed. That is, on taxiway 6 at ORD the airplanes travel 50% faster than on taxiway 10 or 25 (multipliers for taxiways 6,10, and 25 are 1.5 1.0, and 1.0 respectively).

Table A.5 shows the operating speed/time per mode. Looking at the operations of an aircraft, eight different modes are seen. These consist of three taxi modes: an idle operation, an approach and landing, and a take off and climb out.

Table A.6 lists, for each airport, the daily airline gate activity. The numbers of each type of aircraft are given for every airline.

Tables A.7a, A.7b and A.7c contains the coordinates for the line sources at ORD, LAX, and JFK. Four different kinds of line sources are used -- runways, taxiways, aprons, and terminal zones. Note that the line source coordinates come in two groups of three numbers each. The first group indicates the start of the line; the second group indicates the end of the line. The last number of each group is the vertical component of the coordinate. In this example it is always zero. The coordinates are relative to reference origin on the a .port map.

Tables A.8a, A.8b, and A.8c give the hourly aircraft arrivals and departures for each airport. These values are for August 4, 1977. For each hour the number of airplanes is listed for every aircraft type.

Table A.9a, A.9b, and A.9c shows the normalized runway and taxiway activity for the three airports. The numbers indicate the relative use of the runways and taxiways for landing and take off.

Table A.1. Runway Parameters

	Arrival Velocity (Mi/hr)		Departure Velocity (Mi/hr)		Takeoff Rolltime (Hr)	Exhaust Tail Length (Mi)	Angle (deg) of	
	Initial	Final	Initial	Final			Approach	Climbout
ORD:	145.0	25.0	0.0	150.0	0.010	0.087	2.5	5.0
LAX:	145.0	25.0	0.0	136.0	0.010	0.087	2.5	5.0
JFK:	145.0	25.0	0.0	150.0	0.010	0.087	2.5	5.0

Table A.2. Initial Spreads of Aircraft Line Sources in Miles

	Runways		Taxiways		Aprons	
	Hor	Ver	Hor	Ver	Hor	Ver
ORD: LAX: JFK:	0.0295	0.0160	0.0270	0.0058	0.0270	0.0058

Table A.3. Initial Terminal Spread in Miles

	Horizontal Spread	Vertical Spread
ORD:	0.12	0.003
LAX:	0.025	0.005
JFK:	0.0124	0.0028

Table A.4. Taxi Speed Multiplier Factors

Taxiway:	1	2	3	4	5	6	7	8	9	10	11	12
ORD:	1.0	1.0	1.0	1.0	0.1	1.5	1.0	1.0	1.0	1.0	1.0	1.0
LAX:	1.5	1.5	1.0	1.0	1.0	1.0	1.0	1.5	1.5	1.5	1.5	1.0
JFK:	1.0	1.0	0.8	0.8	1.0	1.0	1.0	1.0	0.8	0.8	1.0	1.0

Taxiway:	13	14	15	16	17	18	19	20	21	22	23	24	25
ORD:	0.1	1.5	1.5	1.5	1.5	1.0	1.0	0.1	1.0	1.5	1.0	1.5	1.0
LAX:	1.0	1.0	1.0	0.8	1.0	1.5	1.5	1.0	1.0	0.1	0.1	0.1	0.1
JFK:	1.0	1.0	1.0										

Table A.5. Operating Speed/Time per Mode

Aircraft Range		1	2	3	4
ORD					
Operating Mode	1	10.	10.	10.	10.
	2	20.	20.	20.	20.
	3	15.	15.	15.	15.
	4	0.05	0.03	0.01	0.01
	5	0.050	0.060	0.050	0.075
	6	0.010	0.010	0.015	0.011
	7	0.012	0.009	0.011	0.011
	8	0.032	0.037	0.032	0.060
LAX					
Operating Mode	1	10.	10.	10.	10.
	2	20.	20.	20.	20.
	3	15.	15.	15.	15.
	4	0.033	0.033	0.033	0.033
	5	0.050	0.060	0.050	0.033
	6	0.010	0.010	0.015	0.011
	7	0.012	0.009	0.009	0.011
	8	0.032	0.037	0.032	0.060
JFK	1	10.	10.	10.	10.
Operating Mode	2	20.	20.	20.	20.
	3	15.	15.	15.	15.
	4	0.05	0.03	0.01	0.01
	5	0.050	0.060	0.050	0.075
	6	0.010	0.010	0.015	0.011
	7	0.012	0.009	0.011	0.011
	8	0.032	0.037	0.032	0.060

Operating Mode Index	Operating Mode	Units
1	Gate area taxi	mi/hr
2	Inbound taxi	mi/hr
3	Outbound taxi	mi/hr
4	Idle	hr
5	Approach	hr
6	Landing	hr
7	Take Off	hr
8	Climbout	hr

Table A.6. Daily Airline Gate Activity

Aircraft type		1	2	3	4	5	6	7	8	9	10	11	12
ORD													
Airline	1	2	0	18	0	29	78	25	0	0	0	24	0
	2	1	3	3	0	9	53	68	0	0	35	0	0
	3	0	7	0	0	21	73	1	0	0	0	0	0
	4	4	0	12	0	18	36	57	0	0	16	0	0
	5	5	0	17	0	25	49	31	0	0	0	0	0
	6	9	3	28	0	93	18	0	0	0	0	0	0
	7	3	3	1	0	15	1	0	0	0	0	0	0
	8	3	4	1	0	16	1	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	11	0	0	89	3
LAX													
Airline	1	04	0	5	0	11	17	05					
	2	0	0	0	0	15	28	06					
	3	07	0	07	0	02	03	01					
	4	0	0	0	0	04	71	13	0	2	4		
	5	0	11	16	0	0	10	02	0	1	1		
	6	0	0	0	0	15	29	25	0				
	7	0	0	0	08	02	04	03	0				
	8	0	0	0	0	17	23	0	0				
	9	06	0	19	0	02	03	0	0				
	10	01	18	0	0	25	16	0	0				
	11	14	03	05	07	13	02	01	0				
	12	0	0	0	0	03	00	0	0	0	76	3	
JFK													
Airline	1	10	0	1	0	10	1	0					
	2	13	0	0	0	7	0	0					
	3	0	0	0	0	0	2	18	3		2	38	
	4	6	0	0	0	3	1	0					
	5	0	12	0	0	1	23	6					
	6	3	0	7	0	17	13	2					
	7	0	3	0	0	2	19						
	8	13	0	7	0	27	5						
	9	3	0	0	0	2	0	0					
	10	0	0	0	0	1	1	11					
	11	0	0	1	1	0	24	0					
	12	1	3	0	0	8	1	1					
	13	3	4	0	0	10	0	1					
	14	2	3	0	0	8	1	0					
	15	18	1	3	0	15	2						

Table A.7a. Line Source Coordinates -- O'Hare International Airport

	Begin Coordinates (Miles)			End Coordinates (Miles)		
	X_1	Y_1	Z_1	X_2	Y_2	Z_2
Runway						
1	1.38000	0.88000	0.0	0.0	2.56000	0.0
2	0.59000	1.07000	0.0	2.48000	1.07000	0.0
3	2.48000	1.07000	0.0	0.59000	1.07000	0.0
4	2.10000	1.92000	0.0	0.90000	3.37000	0.0
5	0.0	2.56000	0.0	1.38000	0.88000	0.0
6	1.87000	3.03000	0.0	0.98000	1.95000	0.0
7	2.70000	1.14000	0.0	1.69000	0.0	0.0
8	0.75000	2.10000	0.0	2.13000	2.10000	0.0
Taxiway						
1	1.07000	1.91000	0.0	1.07000	1.58000	0.0
2	1.07000	1.58000	0.0	1.21000	1.30000	0.0
3	1.21000	1.30000	0.0	1.74000	1.30000	0.0
4	1.74000	1.30000	0.0	1.92000	1.47000	0.0
5	1.08000	1.39000	0.0	1.13800	1.44600	0.0
6	1.12000	1.55000	0.0	1.12000	1.90000	0.0
7	1.24000	1.35000	0.0	1.12000	1.55000	0.0
8	1.76000	1.35000	0.0	1.24000	1.35000	0.0
9	1.88000	1.52000	0.0	1.76000	1.35000	0.0
10	2.02000	1.89000	0.0	2.13000	1.97000	0.0
11	1.74000	1.30000	0.0	1.97000	1.30000	0.0
12	1.97000	1.30000	0.0	1.97000	1.17000	0.0
13	1.[illegible]00	1.17000	0.0	2.48000	1.17000	0.0
14	0.96000	1.39000	0.0	1.08000	1.39000	0.0
15	1.75000	0.22000	0.0	1.92000	0.42000	0.0
16	1.92000	0.42000	0.0	1.34000	1.10000	0.0
17	1.86000	1.07000	0.0	1.97000	1.17000	0.0
18	1.97000	1.17000	0.0	1.97000	1.30000	0.0
19	1.97000	1.30000	0.0	1.74000	1.30000	0.0
20	1.04000	2.03000	0.0	0.85000	2.03000	0.0
21	0.75000	2.03000	0.0	0.75000	2.10000	0.0
22	1.91700	0.25800	0.0	1.75000	0.22000	0.0
23	1.12000	1.90000	0.0	1.32000	2.04000	0.0
24	1.32000	2.04000	0.0	1.91000	2.04000	0.0
25	1.91000	2.04000	0.0	2.02000	1.89000	0.0

(cont'd)

Table A.7a. (Cont'd)

	Begin Coordinates (Miles)			End Coordinates (Miles)		
	X_1	Y_1	Z_1	X_2	Y_2	Z_2
Apron						
1	1.61000	0.88000	0.0	1.38000	0.88000	0.0
2	2.13000	1.97000	0.0	2.13000	2.10000	0.0
3	2.48000	1.17000	0.0	2.48000	1.07000	0.0
4	1.92000	1.81000	0.0	2.10000	1.92000	0.0
5	0.16000	2.50000	0.0	0.10000	2.58000	0.0
6	1.92000	2.97000	0.0	1.87000	3.03000	0.0
7	2.48000	1.17000	0.0	2.70000	1.14000	0.0
8	8.50000	2.03000	0.0	0.75000	2.03000	0.0
Terminal Zone						
1	1.88000	1.52000	0.0	1.65000	1.50000	0.0
2	1.66000	1.35000	0.0	1.66000	1.47000	0.0
3	1.51000	1.35000	0.0	1.51000	1.50000	0.0
4	1.36000	1.35000	0.0	1.36000	1.49000	0.0
5	1.18500	1.44200	0.0	1.32000	1.50000	0.0
6	1.12000	1.60000	0.0	1.32000	1.65000	0.0
7	1.12000	1.73000	0.0	1.21000	1.72000	0.0
8	1.12000	1.86000	0.0	1.21000	1.72000	0.0
9	1.12000	1.90000	0.0	1.32000	1.86000	0.0

Table A.7b. Line Source Coordinates -- Los Angeles International Airport

	Begin Coordinates (Miles)			End Coordinates (Miles)		
	X_1	Y_1	Z_1	X_2	Y_2	Z_2
Runway						
1	1.88300	1.47300	0.0	0.24590	1.27340	0.0
2	1.90730	1.90730	0.0	0.05020	1.11560	0.0
3	3.16000	0.62000	0.0	0.72500	0.34000	0.0
4	3.16210	0.47830	0.0	0.90980	0.11960	0.0
5	0.90980	0.21960	0.0	3.16210	0.47830	0.0
6	0.72500	0.34000	0.0	3.16000	0.62000	0.0
7	0.05020	1.11560	0.0	1.90730	1.34010	0.0
8	0.24950	1.27340	0.0	1.88300	1.47300	0.0
Taxiway						
1	0.65780	1.32480	0.0	0.41220	1.16000	0.0
2	0.41220	1.16000	0.0	0.41000	1.08000	0.0
3	0.41000	1.08000	0.0	0.65000	1.11000	0.0
4	1.29910	1.18780	0.0	1.51220	1.21280	0.0
5	1.29910	1.18780	0.0	1.38500	1.50000	0.0
6	1.38500	0.50000	0.0	1.57000	0.55000	0.0
7	1.47500	0.65000	0.0	1.44000	0.88000	0.0
8	1.91220	0.33330	0.0	1.72000	0.46000	0.0
9	2.29600	0.37920	0.0	2.06480	0.49480	0.0
10	2.06480	0.49480	0.0	1.97950	0.59600	0.0
11	1.72000	0.46000	0.0	1.57000	0.55000	0.0
12	2.16000	0.57000	0.0	2.91500	0.66000	0.0
13	1.42000	1.07000	0.0	1.51220	1.21280	0.0
14	0.65000	1.11000	0.0	1.29910	1.87800	0.0
15	2.10000	0.61000	0.0	2.16000	0.57000	0.0
16	1.57000	0.55000	0.0	2.10000	0.61000	0.0
17	1.57000	0.55000	0.0	1.47500	0.65000	0.0
18	0.77650	1.20180	0.0	0.65000	1.11000	0.0
19	1.04300	1.37200	0.0	0.77650	1.20180	0.0
20	1.44000	0.88000	0.0	1.42000	1.07000	0.0
21	1.51220	1.21800	0.0	1.66940	1.23120	0.0
22	1.92140	1.26180	0.0	1.9073	1.34010	0.0
23	1.90730	1.34010	0.0	1.88300	1.47300	0.0
24	3.15000	0.68000	0.0	3.16000	0.62000	0.0
25	3.16000	0.62000	0.0	3.16210	0.47830	0.0

(cont'd)

Table A.7b. (Cont'd)

	Begin Coordinates (Miles)			End Coordinates (Miles)		
	X_1	Y_1	Z_1	X_2	Y_2	Z_2
Apron						
1	1.66940	1.23120	0.0	1.92140	1.26180	0.0
2	1.66940	1.23120	0.0	1.92140	1.26180	0.0
3	2.91500	0.66000	0.0	3.15000	0.68000	0.0
4	2.91500	0.66000	0.0	3.15000	0.68000	0.0
5	2.91500	0.>6000	0.0	3.15000	0.68000	0.0
6	2.91500	0.66000	0.0	3.15000	0.68000	0.0
7	2.91500	0.66000	0.0	3.15000	0.68000	0.0
8	2.91500	0.6600	0.0	3.15000	0.68000	0.0
Terminal Zone						
1	2.11000	0.82000	0.0	2.10000	0.61000	0.0
2	2.02900	0.71300	0.0	2.10000	0.61000	0.0
3	2.02900	0.71300	0.0	1.97950	0.59600	0.0
4	1.90000	0.70000	0.0	1.97950	0.59600	0.0
5	1.90000	0.70000	0.0	1.84250	0.58010	0.0
6	1.75800	0.68200	0.0	1.84250	0.58010	0.0
7	1.75800	0.68200	0.0	1.70000	0.56420	0.0
8	1.61200	0.66600	0.0	1.70000	0.56420	0.0
9	1.61200	0.66000	0.0	1.57000	0.55000	0.0
10	1.58000	1.11000	0.0	1.66940	1.23120	0.0
11	1.76000	1.13000	0.0	1.84190	1.25260	0.0
12	1.44000	0.88000	0.0	1.52400	0.89300	0.0

Table A.7c. Line Source Coordinates -- Kennedy International Airport

	Begin Coordinates (Miles)			End Coordinates (Miles)		
	X_1	Y_1	Z_1	X_2	Y_2	Z_2
Runway						
1	3.405	1.775	0.0	2.583	0.440	0.0
2	2.885	2.020	0.0	1.653	0.195	0.0
3	0.200	2.000	0.0	2.475	0.610	0.0
4	1.583	2.670	0.0	3.163	1.695	0.0
5	2.583	0.440	0.0	3.402	1.775	0.0
6	1.763	0.195	0.0	2.885	2.020	0.0
7	2.475	0.610	0.0	0.200	2.000	0.0
8	3.173	1.695	0.0	1.583	2.670	0.0
Taxiway						
1	0.340	2.043	0.0	1.160	1.504	0.0
2	1.160	1.501	0.0	1.300	1.525	0.0
3	1.300	1.525	0.0	1.335	2.025	0.0
4	1.335	2.025	0.0	1.875	2.375	0.0
5	1.630	2.535	0.0	1.875	1.375	0.0
6	1.875	2.375	0.0	2.635	1.850	0.0
7	2.690	1.700	0.0	2.545	1.725	0.0
8	2.893	1.775	0.0	2.690	1.700	0.0
9	2.088	0.990	0.0	2.635	1.850	0.0
10	1.300	1.525	0.0	2.088	0.990	0.0
11	3.215	1.965	0.0	2.893	1.775	0.0
12	3.360	1.883	0.0	3.215	1.965	0.0
13	1.670	0.250	0.0	2.088	0.990	0.0
14	2.710	2.000	0.0	2.635	1.850	0.0
15	2.625	0.710	0.0	2.690	1.700	0.0

Table A.7c. (Cont'd)

	Begin Coordinates (Miles)			End Coordinates (Miles)		
	X_1	Y_1	Z_1	X_2	Y_2	Z_2
Apron						
1	3.405	1.775	0.0	3.360	1.883	0.0
2	2.855	2.020	0.0	2.710	2.000	0.0
3	0.200	2.000	0.0	0.340	2.043	0.0
4	1.583	2.670	0.0	1.630	2.535	0.0
5	2.475	0.610	0.0	2.790	0.775	0.0
6	1.763	0.195	0.0	1.670	0.250	0.0
7	2.475	0.610	0.0	2.790	0.775	0.0
8	3.163	1.695	0.0	2.893	1.775	0.0
Terminal Zone						
1	1.975	1.075	0.0	1.840	1.355	0.0
2	1 640	1.315	0.0	1.720	1.335	0.0
3	1.518	1.385	0.0	1.605	1.430	0.0
4	1.410	1.443	0.0	1.470	1.545	0.0
5	1.320	1.650	0.0	1.420	1.640	0.0
6	1.335	1.855	0.0	1.423	1.883	0.0
7	1.335	2.025	0.0	1.493	1.978	0.0
8	1.630	2.190	0.0	1.588	2.023	0.0
9	1.740	2.260	0.0	1.700	2.080	0.0
10	2.100	2.210	0.0	2.028	2.085	0.0
11	2.250	2.120	0.0	2.138	1.983	0.0
12	2.320	2.050	0.0	2.190	1.905	0.0
13	2.545	1.725	0.0	2.360	1.750	0.0
14	2.390	1.465	0.0	2.320	1.705	0.0
15	2.260	1.260	0.0	2.000	1.595	0.0

Table A.8a. Hourly Aircraft Operations -- O'Hare International Airport

Aircraft type		1	2	3	4	5	6	7	8	9	10	11	12
Arrivals													
Hour:	0	0	0	0	0	1	2	0	0	0	0	0	0
	1	3	2	0	0	4	0	1	1	0	0	2	0
	2	0	0	1	0	6	0	0	2	0	0	0	0
	3	1	0	0	0	2	1	0	1	0	0	0	0
	4	0	0	3	0	3	0	0	0	0	0	3	0
	5	1	2	4	0	6	3	0	1	0	0	0	2
	6	3	0	1	0	3	1	0	2	0	0	2	0
	7	1	1	2	0	4	12	15	0	0	4	10	0
	8	0	2	4	0	4	19	9	1	0	2	9	0
	9	1	1	7	0	5	6	12	1	0	3	4	0
	10	2	1	2	0	5	25	11	0	0	4	7	0
	11	1	0	5	0	6	26	12	0	0	1	7	0
	12	1	2	5	0	7	26	18	0	0	2	4	0
	13	1	0	6	0	7	34	13	1	0	6	8	0
	14	2	0	4	0	12	34	17	0	0	3	7	0
	15	4	2	3	0	8	17	8	0	0	4	6	0
	16	4	1	8	0	10	24	14	0	0	4	7	0
	17	0	0	4	0	10	25	19	0	0	3	7	0
	18	1	3	3	0	4	28	10	1	0	3	5	0
	19	0	2	8	0	4	26	10	0	0	5	8	0
	20	0	0	6	0	10	30	13	0	0	2	6	0
	21	0	1	3	0	9	16	13	0	0	1	4	0
	22	0	0	0	0	4	2	3	0	0	3	3	1
	23	1	0	2	0	1	7	2	0	0	1	4	0

Table A.8a. (Cont'd)

Aircraft type		1	2	3	4	5	6	7	8	9	10	11	12
Departures													
Hour:	0	1	0	0	0	0	0	0	0	0	0	1	0
	1	0	0	0	0	1	1	1	0	0	0	1	0
	2	1	1	0	0	4	0	2	0	0	0	1	0
	3	3	0	0	0	5	0	2	0	0	0	1	0
	4	1	0	1	0	1	1	3	0	0	0	1	0
	5	0	0	1	0	3	1	0	0	0	0	1	0
	6	0	1	4	0	6	7	10	0	0	2	0	2
	7	3	1	3	0	8	18	11	0	0	4	8	0
	8	1	0	5	0	7	25	17	0	0	3	11	0
	9	0	5	3	0	3	16	10	1	0	3	8	0
	10	3	0	8	0	9	30	11	0	0	3	4	0
	11	1	2	3	0	6	32	13	0	0	2	10	0
	12	0	0	5	0	3	21	11	0	0	3	6	0
	13	2	2	5	0	7	24	16	0	0	2	5	0
	14	1	0	3	0	8	35	13	1	0	8	9	0
	15	2	0	6	0	8	35	15	1	0	1	3	0
	16	1	2	5	0	8	18	9	0	0	6	5	0
	17	4	1	4	0	11	22	12	0	0	1	12	0
	18	2	0	6	0	8	29	16	0	0	4	4	0
	19	1	2	4	0	5	25	17	1	0	3	4	0
	20	1	1	6	0	16	15	10	1	0	4	11	0
	21	0	1	3	0	9	16	13	0	0	1	4	0
	22	0	0	6	0	3	2	4	0	0	0	2	1
	23	0	0	0	0	5	0	1	0	0	0	1	2

Table A.8b. Hourly Aircraft Operations -- Los Angeles International Airport

Aircraft type		1	2	3	4	5	6	7	8	9	10	11	12
Departures													
Hour:	0	1	2	2	0	4	6	0	2	0	0	0	0
	1	1	3	2	0	2	0	1	0	0	0	0	0
	2	0	1	1	0	1	1	0	2	0	0	0	0
	3	0	0	0	0	1	2	0	0	0	0	0	0
	4	1	0	0	0	3	1	0	0	0	0	0	0
	5	0	0	0	0	4	0	0	0	0	0	0	0
	6	1	0	1	0	6	1	0	0	0	0	3	1
	7	1	1	0	1	4	3	4	0	0	1	7	0
	8	1	0	1	0	2	16	3	0	0	1	5	0
	9	0	3	0	0	2	11	1	0	0	0	4	0
	10	1	0	5	0	5	17	5	0	0	0	4	0
	11	1	3	6	3	5	8	4	0	1	1	6	0
	12	1	1	2	0	8	13	3	0	0	0	6	0
	13	0	0	3	0	2	12	2	0	0	0	4	0
	14	3	3	2	1	4	13	3	0	0	0	4	0
	15	3	1	1	1	7	13	7	0	0	0	4	0
	16	2	0	3	0	4	12	3	0	1	1	6	1
	17	3	1	2	1	3	12	4	0	0	0	5	1
	18	1	1	2	1	13	15	4	0	0	0	4	0
	19	1	4	10	2	9	14	3	0	0	1	3	0
	20	4	3	3	2	6	11	2	0	0	0	6	0
	21	5	5	0	2	6	7	5	0	1	0	3	0
	22	3	0	2	0	9	6	3	0	0	0	2	0
	23	1	1	4	1	4	8	0	0	0	0	1	0

Table A.8b. (Cont'd)

Aircraft type		1	2	3	4	5	6	7	8	9	10	11	12
Departures													
Hour:	0	0	0	0	0	0	0	0	0	0	0	0	0
	1	0	0	0	0	0	0	0	0	0	0	0	0
	2	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	1	0	0	0	0	2	0	0	0	0
	4	0	0	0	0	1	0	0	1	0	0	0	0
	5	0	0	0	0	2	0	0	0	0	0	0	0
	6	1	0	0	0	1	4	1	0	0	0	4	0
	7	1	0	1	0	6	12	3	0	0	0	5	1
	8	1	5	4	2	5	19	8	0	1	0	5	0
	9	1	4	8	2	7	16	2	0	0	2	6	0
	10	4	2	2	0	5	13	4	0	0	0	6	0
	11	1	2	3	0	3	13	3	0	0	0	2	0
	12	2	1	6	4	4	15	3	0	1	1	6	0
	13	4	4	2	1	9	14	4	0	0	0	4	0
	14	0	0	1	1	1	13	2	0	0	0	5	0
	15	1	1	3	1	4	12	4	0	0	0	6	0
	16	1	0	1	0	7	12	7	0	0	0	4	0
	17	0	0	1	0	4	16	3	0	0	0	5	0
	18	2	2	4	1	12	8	3	0	1	1	4	2
	19	1	1	0	0	8	14	4	0	0	0	6	0
	20	1	0	2	0	4	6	2	0	0	1	5	0
	21	2	2	2	0	5	5	4	0	0	0	4	0
	22	2	6	3	1	8	4	0	0	0	0	3	0
	23	4	3	1	1	8	2	1	0	0	0	0	0

Table A.8c. Hourly Aircraft Operations -- Kennedy International Airport

Aircraft type		1	2	3	4	5	6	7	8	9	10	11	12
Departures													
Hour:	0	0	1	0	1	2	8	0	0	0	0	0	0
	1	0	1	0	0	0	3	0	1	0	0	0	0
	2	3	2	0	0	3	1	0	0	0	0	1	0
	3	2	0	0	0	0	0	0	1	0	0	1	0
	4	0	0	0	0	0	0	0	1	0	0	0	0
	5	2	0	0	0	3	0	0	0	0	0	0	0
	6	3	2	0	0	3	0	0	0	0	0	1	0
	7	4	0	2	0	5	0	1	0	0	0	3	0
	8	0	0	0	0	8	3	1	0	0	0	4	0
	9	1	0	0	0	1	0	2	0	0	0	2	0
	10	1	0	0	0	5	3	3	0	0	0	0	0
	11	2	1	1	0	2	4	0	0	0	0	3	0
	12	1	0	0	0	2	1	3	0	0	0	1	0
	13	3	1	1	0	4	4	1	0	0	0	1	0
	14	5	2	1	0	6	5	2	0	0	0	2	0
	15	13	0	1	0	9	10	5	0	0	1	4	0
	16	11	4	2	0	10	8	3	0	0	1	4	0
	17	6	3	3	0	10	7	4	0	0	0	3	0
	18	4	1	1	0	7	6	5	1	0	0	2	0
	19	3	3	0	0	10	7	3	0	0	0	3	0
	20	5	1	4	0	8	4	2	0	0	0	2	0
	21	2	2	2	0	6	9	0	0	0	0	1	0
	22	0	2	1	0	2	1	2	0	0	0	0	0
	23	0	0	0	0	5	3	2	0	0	0	0	0

Table A.8c. (Cont'd)

Aircraft type		1	2	3	4	5	6	7	8	9	10	11	12
Departures													
Hour:	0	3	0	0	0	3	1	0	0	0	0	0	0
	1	1	0	0	0	3	1	0	1	0	0	0	0
	2	0	0	0	0	1	1	2	0	0	0	0	0
	3	0	1	0	0	3	0	0	0	0	0	1	0
	4	2	0	0	0	1	0	0	0	0	0	1	0
	5	0	0	0	0	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	1	0	0	1	0
	7	1	1	0	0	7	1	1	0	0	0	1	0
	8	2	1	0	0	6	6	0	0	0	1	2	0
	9	4	3	1	1	14	8	1	0	0	0	2	0
	10	4	2	0	0	8	2	2	0	0	0	1	0
	11	1	1	1	0	5	5	1	0	0	0	2	0
	12	5	2	0	0	3	3	2	0	0	0	1	0
	13	0	0	1	0	6	2	2	0	0	0	2	0
	14	0	1	1	0	1	5	1	0	0	0	1	0
	15	11	0	0	0	3	3	2	1	0	0	2	0
	16	10	0	1	0	10	9	1	0	0	1	3	0
	17	2	5	2	0	4	8	3	0	0	1	3	0
	18	6	3	4	0	7	6	3	1	0	0	3	0
	19	14	1	1	0	7	8	5	0	2	0	4	0
	20	12	0	1	0	10	2	0	0	0	0	3	0
	21	7	3	2	0	9	12	2	0	0	0	3	0
	22	5	1	3	0	7	2	1	0	0	0	0	0
	23	1	0	1	0	3	0	0	0	0	0	2	0

Table A.9a. Normalized Runway Activity - O'Hare International Airport

Aircraft Class:		1	2	3	4	5	6
Landing Runway:	1	0.0	0.0	0.0	0.0	0.0	0.0
	2	0.0	0.300	0.300	0.300	0.300	0.300
	3	0.0	0.0	0.0	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.0	0.0	0.0
	5	0.0	0.300	0.300	0.300	0.300	0.300
	6	0.0	0.300	0.300	0.300	0.300	0.300
	7	0.0	0.0	0.0	0.0	0.0	0.0
	8	0.0	0.0	0.0	0.0	0.0	0.0
Takeoff Runway:	1	0.0	0.0	0.0	0.0	0.0	0.0
	2	0.0	0.0	0.0	0.0	0.0	0.0
	3	0.0	0.0	0.0	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.0	0.0	0.0
	5	0.0	0.0	0.0	0.0	0.0	0.0
	6	0.0	0.0	0.0	0.0	0.0	0.0
	7	0.0	0.500	0.500	0.500	0.500	0.500
	8	0.0	0.500	0.500	0.500	0.500	0.500

Table A.9a. (Cont'd)

Aircraft Class		1	2	3	4	5	6
Landing Taxiway:	1	0.0	0.300	0.300	0.300	0.300	0.300
	2	0.0	0.300	0.300	0.300	0.300	0.300
	3	0.0	0.500	0.500	0.500	0.500	0.500
	4	0.0	0.400	0.400	0.400	0.400	0.400
	5	0.0	0.0	0.0	0.0	0.0	0.0
	6	0.0	0.300	0.300	0.300	0.300	0.300
	7	0.0	0.200	0.200	0.200	0.200	0.200
	8	0.0	0.500	0.500	0.500	0.500	0.500
	9	0.0	0.300	0.300	0.300	0.300	0.300
	10	0.0	0.300	0.300	0.300	0.300	0.300
	11	0.0	0.0	0.0	0.0	0.0	0.0
	12	0.0	0.0	0.0	0.0	0.0	0.0
	13	0.0	0.0	0.0	0.0	0.0	0.0
	14	0.0	0.0	0.0	0.0	0.0	0.0
	15	0.0	0.300	0.300	0.300	0.300	0.300
	16	0.0	0.0	0.0	0.0	0.0	0.0
	17	0.0	0.0	0.0	0.0	0.0	0.0
	18	0.0	0.300	0.300	0.300	0.300	0.300
	19	0.0	0.300	0.300	0.300	0.300	0.300
	20	0.0	0.300	0.300	0.300	0.300	0.300
	21	0.0	0.0	0.0	0.0	0.0	0.0
	22	0.0	0.0	0.0	0.0	0.0	0.0
	23	0.0	0.0	0.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0	0.0	0.0
	25	0.0	0.0	0.0	0.0	0.0	0.0
Take off Taxiway:	1	0.0	0.0	0.0	0.0	0.0	0.0
	2	0.0	0.0	0.0	0.0	0.0	0.0
	3	0.300	0.300	0.300	0.300	0.300	0.300
	4	0.0	0.300	0.300	0.300	0.300	0.300
	5	0.0	0.0	0.0	0.0	0.0	0.0
	6	0.0	0.0	0.0	0.0	0.0	0.0
	7	0.0	0.500	0.500	0.500	0.500	0.500
	8	0.0	0.500	0.500	0.500	0.500	0.500
	9	0.0	0.300	0.300	0.300	0.300	0.300
	10	0.0	0.100	0.100	0.100	0.100	0.100
	11	0.0	0.0	0.0	0.0	0.0	0.0
	12	0.0	0.500	0.500	0.500	0.500	0.500
	13	0.0	0.500	0.500	0.500	0.500	0.500
	14	0.0	0.500	0.500	0.500	0.500	0.500
	15	0.0	0.0	0.0	0.0	0.0	0.0
	16	0.0	0.0	0.0	0.0	0.0	0.0
	17	0.0	0.0	0.0	0.0	0.0	0.0
	18	0.0	0.0	0.0	0.0	0.0	0.0
	19	0.0	0.0	0.0	0.0	0.0	0.0

(Cont'd)

Table A.9a. (Cont'd)

20	0.0	0.0	0.0	0.0	0.0	0.0
21	0.0	0.500	0.500	0.500	0.500	0.500
22	0.0	0.500	0.500	0.500	0.500	0.500
23	0.0	0.0	0.0	0.0	0.0	0.0
24	0.0	0.0	0.0	0.0	0.0	0.0
25	0.0	0.0	0.0	0.0	0.0	0.0

Table A.9b. Normalized Runway Activity -- Los Angeles International Airport

Aircraft Class		1	2	3	4	5	6
Landing Taxiway:	1	0.0	0.110	0.50	0.100	0.0	0.0
	2	0.0	0.340	0.090	0.050	0.500	0.1000
	3	0.0	0.060	0.320	0.640	0.500	0.0
	4	0.0	0.450	0.550	0.170	0.0	0.0
	5	0.0	0.0	0.0	0.0	0.0	0.0
	6	0.0	0.0	0.0	0.0	0.0	0.0
	7	0.0	0.0	0.0	0.0	0.0	0.0
	8	0.0	0.0	0.0	0.0	0.0	0.0
Take off Taxiway:	1	0.0	0.70	0.0	0.0	0.0	0.0
	2	0.0	0.930	0.100	0.120	0.500	0.1000
	3	0.0	0.0	0.850	0.730	0.500	0.0
	4	0.0	0.0	0.050	0.150	0.0	0.0
	5	0.0	0.0	0.0	0.0	0.0	0.0
	6	0.0	0.0	0.0	0.0	0.0	0.0
	7	0.0	0.0	0.0	0.0	0.0	0.0
	8	0.0	0.0	0.0	0.0	0.0	0.0

Table A.9b. (Cont'd)

Aircraft Class		1	2	3	4	5	6
Landing Taxiway:	1	0.0	0.60	0.030	0.050	0.0	0.0
	2	0.0	0.230	0.070	0.080	0.200	0.0
	3	0.0	0.230	0.070	0.080	0.200	0.0
	4	0.0	0.090	0.040	0.030	0.0	0.0
	5	0.0	0.360	0.100	0.120	0.500	0.0
	6	0.0	0.360	0.100	0.120	0.500	0.0
	7	0.0	0.100	0.280	0.170	0.0	0.0
	8	0.0	0.090	0.180	0.040	0.100	0.0
	9	0.0	0.0	0.370	0.130	0.400	0.0
	10	0.0	0.0	0.570	0.640	0.400	0.0
	11	0.0	0.510	0.280	0.170	0.100	0.0
	12	0.0	0.0	0.0	0.0	0.0	0.0
	13	0.0	0.100	0.280	0.170	0.0	0.0
	14	0.0	0.450	0.140	0.150	0.050	1.000
	15	0.0	0.0	0.0	0.0	0.0	0.0
	16	0.0	0.510	0.850	0.810	0.500	0.0
	17	0.0	0.100	0.280	0.170	0.0	0.0
	18	0.0	0.220	0.070	0.070	0.200	1.000
	19	0.0	0.050	0.020	0.500	0.0	0.400
	20	0.0	0.100	0.280	0.170	0.0	0.0
	21	0.0	0.090	0.040	0.030	0.0	0.0
	22	0.0	0.0	0.0	0.0	0.0	0.0
	23	0.0	0.0	0.0	0.0	0.0	0.0
	24	0.0	0.0	0.0	0.0	0.0	0.0
	25	0.0	0.0	0.0	0.0	0.0	0.0
Takeoff Taxiway:	1	0.0	0.0	0.0	0.0	0.0	0.0
	2	0.0	0.0	0.0	0.0	0.0	0.0
	3	0.0	0.0	0.0	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.0	0.0	0.0
	5	0.0	0.0	0.0	0.0	0.0	0.0
	6	0.0	0.0	0.0	0.0	0.0	0.0
	7	0.0	0.630	0.100	0.120	0.500	0.0
	8	0.0	0.0	0.0	0.0	0.0	0.0
	9	0.0	0.0	0.0	0.0	0.0	0.0
	10	0.0	0.0	0.0	0.0	0.0	0.0
	11	0.0	0.0	0.0	0.0	0.0	0.0
	12	0.0	0.0	0.900	0.880	0.500	0.0
	13	0.0	0.630	0.100	0.120	0.500	1.000
	14	0.0	0.0	0.0	0.0	0.0	0.0
	15	0.0	0.0	0.900	0.880	0.500	0.0
	16	0.0	0.0	0.900	0.880	0.500	0.0
	17	0.0	0.630	0.100	0.120	0.500	0.0
	18	0.0	0.0	0.0	0.0	0.0	0.0
	19	0.0	0.0	0.0	0.0	0.0	0.0

(Cont'd)

Table A.9b. (Cont'd)

20	0.0	0.630	0.100	0.120	0.500	1.000
21	0.0	0.630	0.100	0.120	0.500	1.000
22	0.0	1.000	01100	0.120	0.500	1.000
23	0.0	0.070	0.0	0.0	0.0	0.400
24	0.0	0.0	0.900	0.880	0.500	0.0
25	0.0	0.0	0.050	0.150	0.0	0.0

Table A.9c. Normalized Runway Activity -- Kennedy International Airport

Aircraft Class		1	2	3	4	5	6
Landing Runway:	1	0.0	0.0	0.0	0.0	0.0	0.0
	2	0.0	0.0	0.0	0.0	0.0	0.0
	3	0.0	0.0	0.0	0.0	0.0	0.0
	4	0.0	0.0	0.0	0.0	0.0	0.0
	5	0.0	0.400	0.400	0.400	0.400	0.400
	6	0.0	0.300	0.300	0.300	0.300	0.300
	7	0.0	0.100	0.100	0.100	0.100	0.100
	8	0.0	0.200	0.200	0.200	0.200	0.200
Take off Runway:	1	0.0	0.0	0.0	0.0	0.0	0.0
	2	0.0	0.0	0.0	0.0	0.0	0.0
	3	0.0	0.400	0.400	0.400	0.400	0.400
	4	0.0	0.300	0.300	0.300	0.300	0.300
	5	0.0	0.100	0.100	0.100	0.100	0.100
	6	0.0	0.200	0.200	0.200	0.200	0.200
	7	0.0	0.0	0.0	0.0	0.0	0.0
	8	0.0	0.0	0.0	0.0	0.0	0.0

Table A.9c. (Contd')

Aircraft Class		1	2	3	4	5	6
Landing Runway:	1	0.0	0.0	0.0	0.0	0.0	0.0
	2	0.0	0.0	0.0	0.0	0.0	0.0
	3	0.0	0.500	0.500	0.500	0.500	0.500
	4	0.0	0.500	0.500	0.500	0.500	0.500
	5	0.0	0.0	0.0	0.0	0.0	0.0
	6	0.0	0.500	0.500	0.500	0.500	0.500
	7	0.0	0.400	0.400	0.400	0.400	0.400
	8	0.0	0.0	0.0	0.0	0.0	0.0
	9	0.0	0.500	0.500	0.500	0.500	0.500
	10	0.0	0.500	0.500	0.500	0.500	0.500
	11	0.0	0.0	0.0	0.0	0.0	0.0
	12	0.0	0.0	0.0	0.0	0.0	0.0
	13	0.0	0.300	0.300	0.300	0.300	0.300
	14	0.0	0.0	0.0	0.0	0.0	0.0
	15	0.0	0.500	0.500	0.500	0.500	0.500
Take off Runway:	1	0.0	0.400	0.400	0.400	0.400	0.400
	2	0.0	0.400	0.400	0.400	0.400	0.400
	3	0.0	0.500	0.500	0.500	0.500	0.500
	4	0.0	0.500	0.500	0.500	0.500	0.500
	5	0.0	0.300	0.300	0.300	0.400	0.400
	6	0.0	0.500	0.500	0.500	0.500	0.500
	7	0.0	0.200	0.200	0.200	0.200	0.200
	8	0.0	0.0	0.0	0.0	0.0	0.0
	9	0.0	0.500	0.500	0.500	0.500	0.500
	10	0.0	0.500	0.500	0.500	0.500	0.500
	11	0.0	0.0	0.0	0.0	0.0	0.0
	12	0.0	0.0	0.0	0.0	0.0	0.0
	13	0.0	0.0	0.0	0.0	0.0	0.0
	14	0.0	0.0	0.0	0.0	0.0	0.0
	15	0.0	0.200	0.200	0.200	0.200	0.200

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